

# Assessment of natural resources and watershed conditions in and adjacent to Acadia National Park

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Peter Vaux  
Sarah Nelson  
Nishi Rajakaruna  
Glen Mittelhauser  
Kathleen Bell  
Blaine Kopp  
John Peckenham  
Gordon Longworth



## Conservation Lands

- | Acadia National Park lands                 |   |
|--|---|
| <span style="color: green;">■</span>       | Fee owned parcel                            |
| <span style="color: darkgreen;">■</span>   | Parcel to be acquired*                      |
| <span style="color: orange;">■</span>      | Conservation easement/to be acquired ( fee) |
| <span style="color: lightorange;">■</span> | Conservation easement                       |
| Other Maine conservation lands             |   |
| <span style="color: red;">■</span>         | Other Maine conservation lands              |

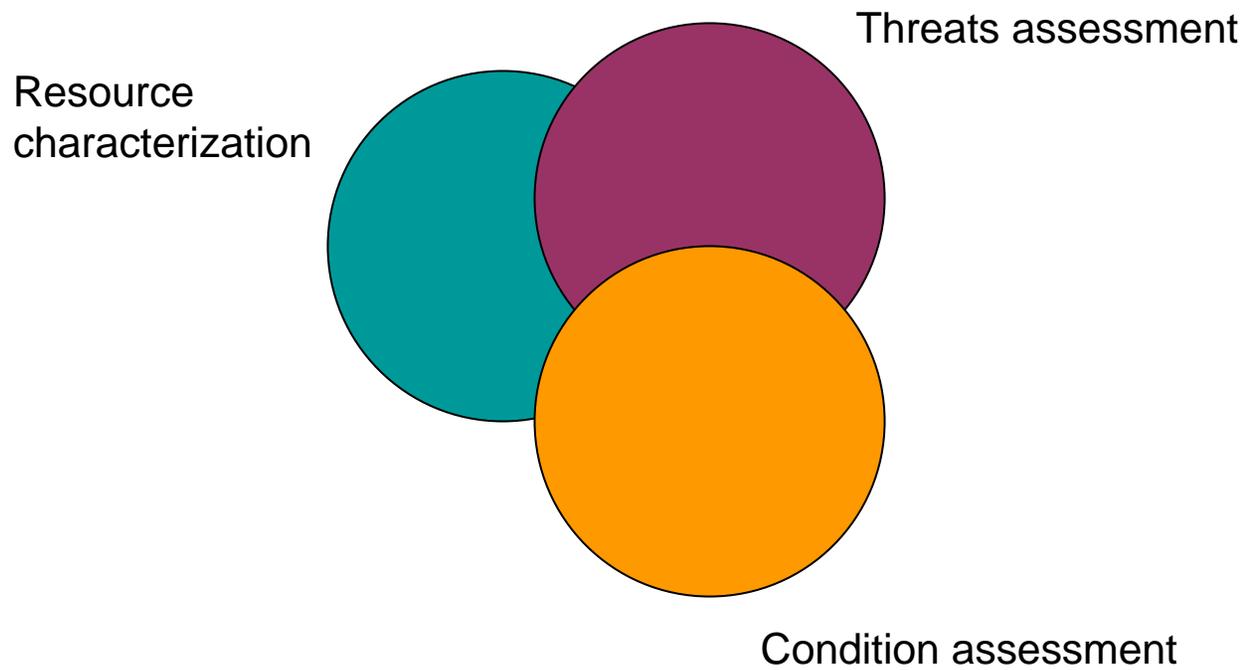
\* Public Law 99-420



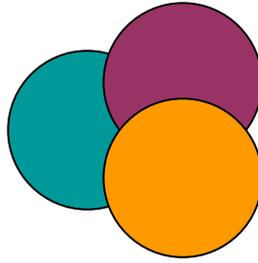
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March 2007

File: E:\Park\_Samp\Baw\_Maps\ACAD\_Slow\_Map.mxd



*... overlaps between resource characterization and threat / condition assessments.*



## Resource characterization

-- *existing & new info. summaries – some examples*



## Threats assessment (agents of change, stresses, system responses)

-- *approach, summary matrices*



## Condition assessment

-- *information availability*

-- *reference / benchmark data*

-- *“grades”*

-- *summary matrices*

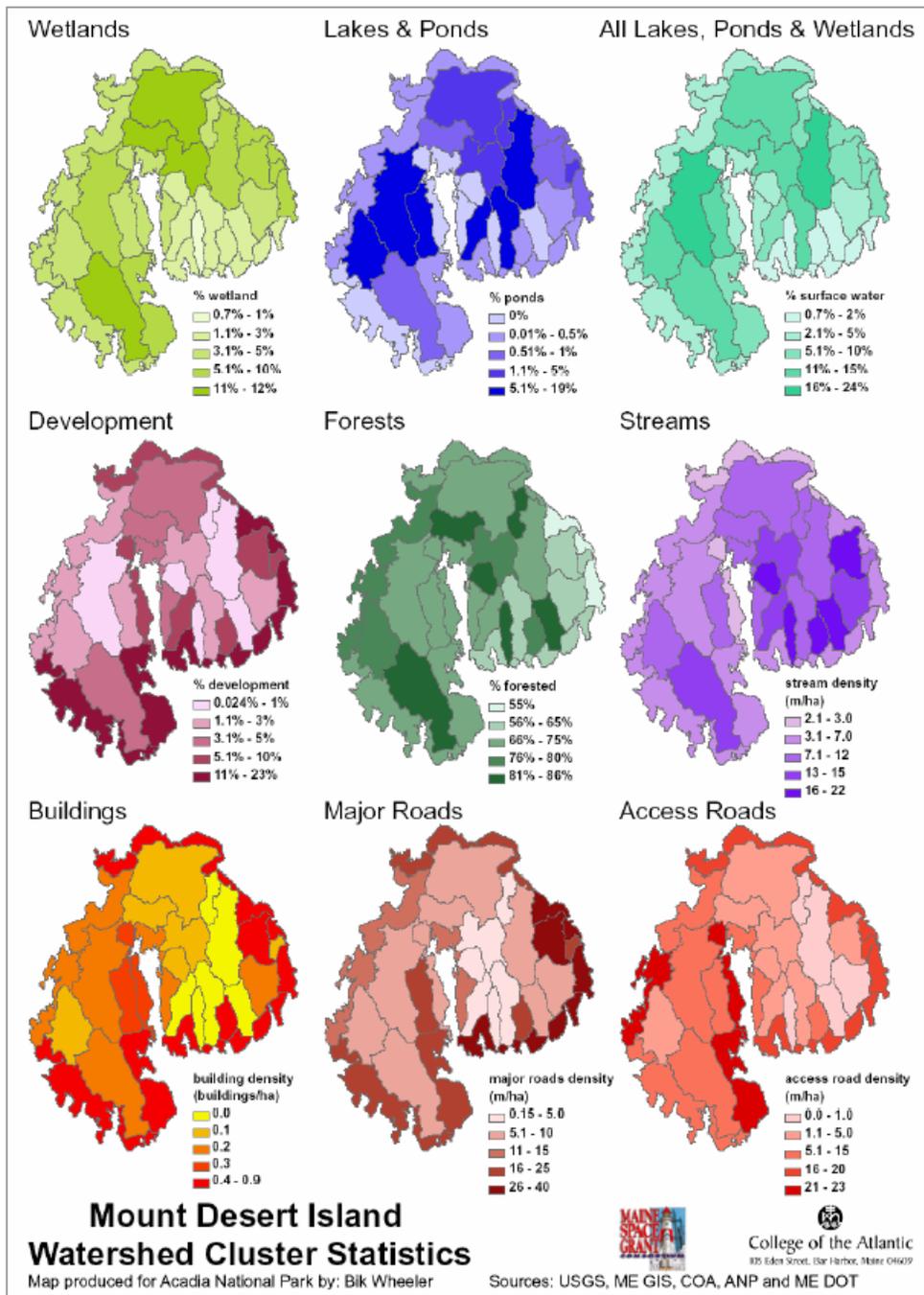


Table 6. Documented taxonomic richness for selected plant and animal groups in ACAD and vicinity. Note that, for some groups, documented diversity is likely less than actual diversity. Data are for MDI, SCH and IAH park units, except where noted.

Group	Number of ACAD Taxa				
	Present in Park *	Unconfirmed in Park *	Historic Records *	Total Taxa	State-Listed Taxa **
Vascular plants <sup>(1)</sup>	894		241	1135	18
Freshwater plants <sup>(1)</sup>				91	6
Fresh and Salt Wetland plants <sup>(10)</sup>				220	
Marine macroalgae <sup>(9)</sup>				146	0
Lichens <sup>(11)</sup>				379 taxa (103 genera)	
Birds <sup>(2)</sup>	230	117	17	364	21
Birds <sup>(3)</sup>				354	
Birds – residents <sup>(4)</sup>				205	
Mammals <sup>(2)</sup>	43	7	1	51	0
Snakes <sup>(2)</sup>	5	-	1	6	1 (historic ACAD record)
Turtles <sup>(2)</sup>	2	3	1	6	2 (both unconfirmed ACAD records)
Amphibians <sup>(2)</sup>	12	1	2	15	0
Fish – freshwater <sup>(2)</sup>	27	-	5	32	0
Fish – estuarine/marine <sup>(2)</sup>	11	3	-	14	0
Fish – Bass Harbor marsh system <sup>(5)</sup>				23	0
Freshwater mussels <sup>(6)</sup>				3	0
Dragonflies/damselflies <sup>(7)</sup>				107	0
Mayflies <sup>(7)</sup>				58	0
Butterflies/Moths <sup>(8)</sup>				155	0
Beetles <sup>(8)</sup>				315	0
Ants <sup>(8)</sup>				44	0

\* 'Present in park' = taxon records from within park boundaries. 'Unconfirmed' = reported in the area but not within park boundaries. 'Historic' = written record of taxon that has not been observed since ca. 1970. For full metadata, see [http://www.pearl.maine.edu/DADDataUpload/MetaData/ACAD05\\_09.HTM](http://www.pearl.maine.edu/DADDataUpload/MetaData/ACAD05_09.HTM).

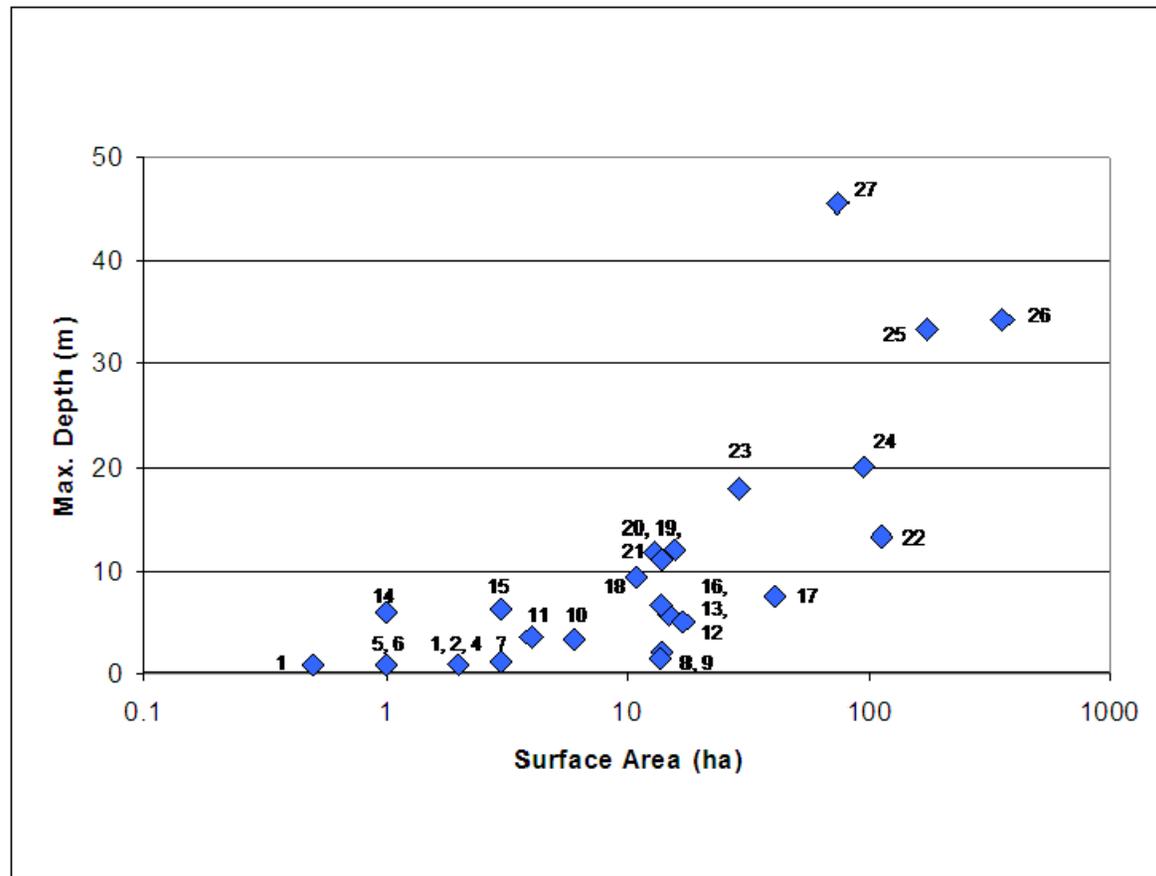
\*\* State endangered and threatened species include faunal taxa proposed for listing (IFW 2007). Endangered and threatened taxa do not include all rare taxa.

#### Data sources

<sup>(1)</sup> Vascular plants: Greene *et al.* 2005. See [Table XX](#) for listing of rare taxa. Freshwater plants: Greene *et al.* 1997.

	LAND SPP.	MARSH SPP.	MARINE SPP.
<b>Total # Species <sup>(A)</sup></b>			
	136	29	40
<b>Priority Status of Taxa <sup>(B)</sup></b>			
<i>Priority</i>	<i># Species</i>		
1	2	1	2
2	39	10	13
3	36	8	13
T	1	0	4
E	2	1	2
SC	6	1	5
<b>Taxa of Regional Concern <sup>(C)</sup></b>			
<i>Concern Level</i>	<i># Species</i>		
Moderate	23	5	8
High	15	2	6
Highest	4	2	8
“Management concern”	--	2	--
<b>Population Trends <sup>(D)</sup></b>			
<i>Trend</i>	<i># Species</i>		
Increasing	18 (MDI); 12 (SCH)	4 (MDI); 1 (SCH)	8 (MDI); 6 (SCH)
Decreasing	3 (MDI); 2 (SCH)	0 (MDI); 1 (SCH)	2 (MDI); 6 (SCH)
No Change	23 (MDI); 23 (SCH)	0 (MDI); 2 (SCH)	13 (MDI); 14 (SCH)
Insufficient data	93 (MDI); 99 (SCH)	25 (MDI); 25 (SCH)	16 (MDI); 13 (SCH)
<b>Population Status Data Quality <sup>(E)</sup></b>			
<i>Quality Category</i>	<i># Species</i>		
1	127	23	23
2	6	6	11
3	0	0	3
4	3	0	2

*Resident Birds –  
new analyses of  
population  
trends*



Name	Code	Name	Code
Bear Brook P	1	Lower Breakneck P	15
The Bowl	2	Hodgdon P	16
Sargent Mountain P	3	Somes P	17
Seawall P	4	Witch Hole P	18
Fawn P	5	Upper Hadlock P	19
Duck P	6	Bubble P	20
The Tarn	7	Lower Hadlock P	21
Little Long P	8	Seal Cove P	22
Aunt Betty's P	9	Long P (IAH)	23
Lake Wood	10	Echo L	24
Upper Breakneck P	11	Eagle L	25
Little Round P	12	Long P	26
Round P	13	Jordan P	27
Half Moon P	14		

Figure 13. ACAD region lakes and ponds: area-depth relationships.

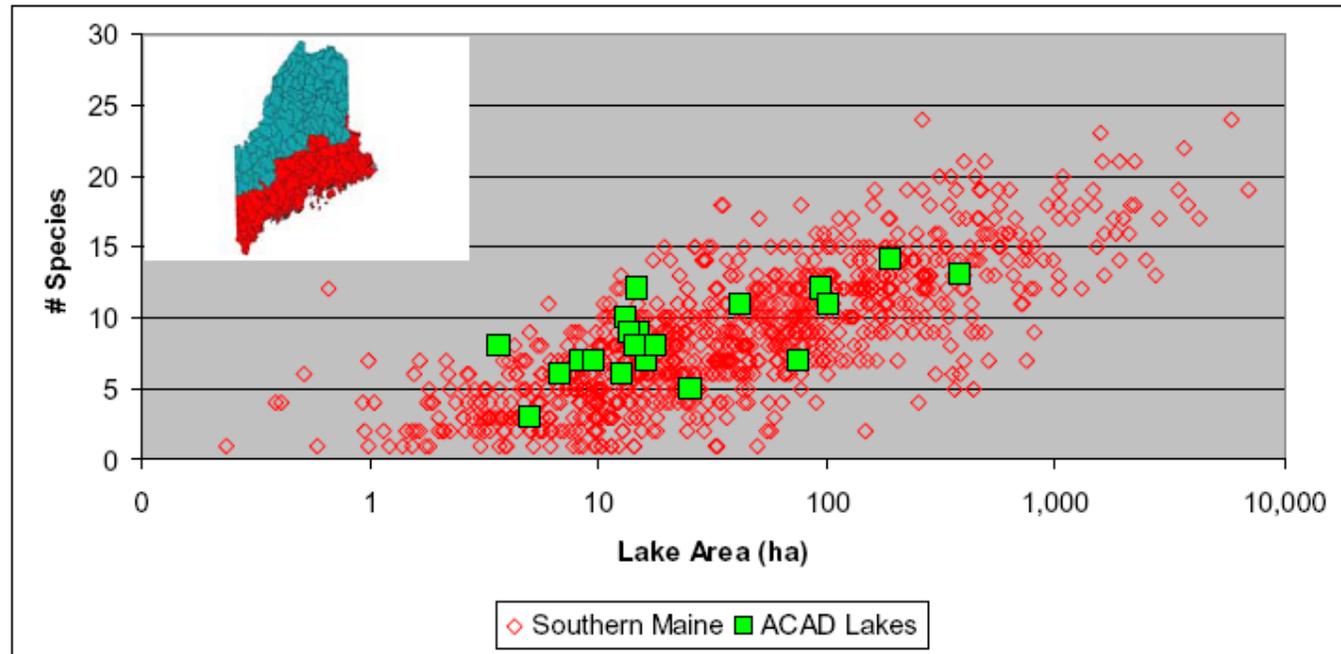
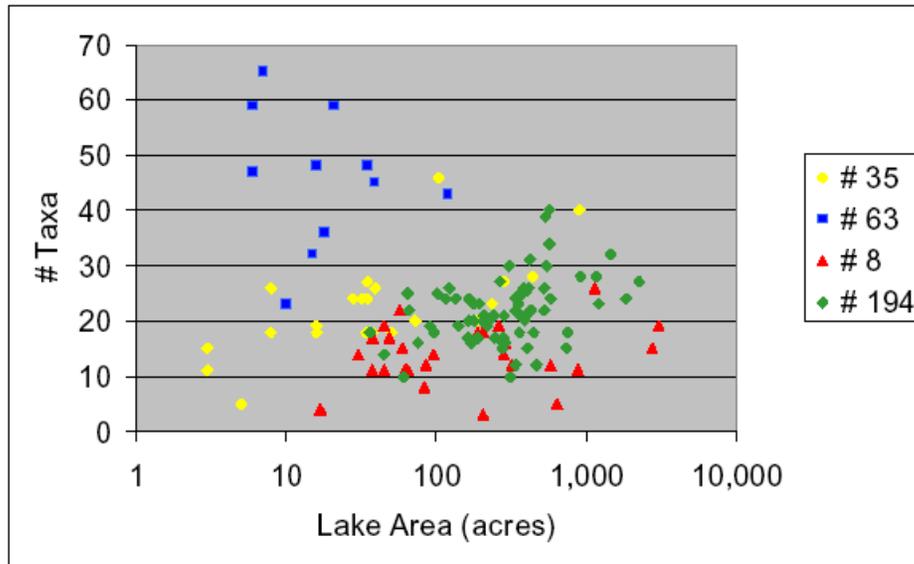


Figure 25. Fish species richness in ACAD area lakes compared to all surveyed lakes in southern Maine (red area in the inset map).

(Note: Sebago lake [12,327 ha, 27 fish species] is excluded from this figure.)

(A)



(B)

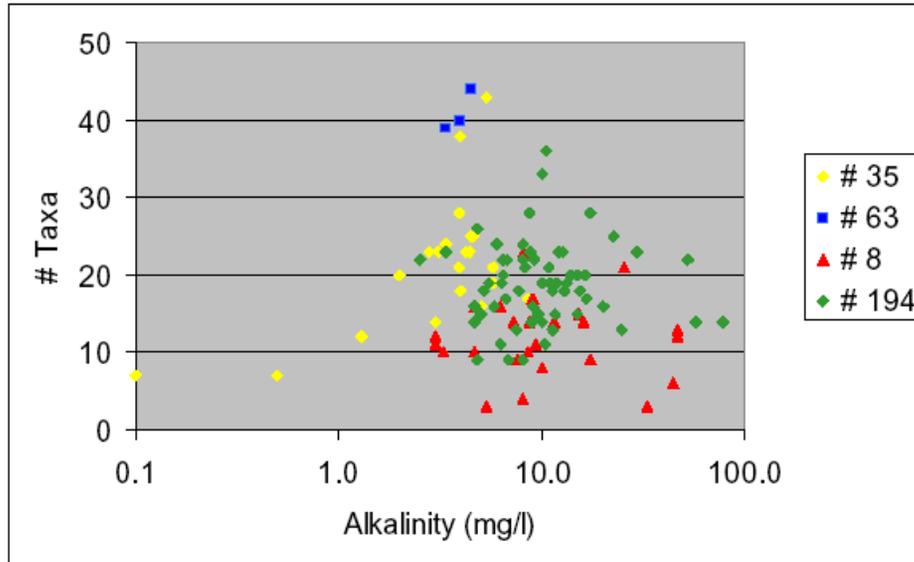
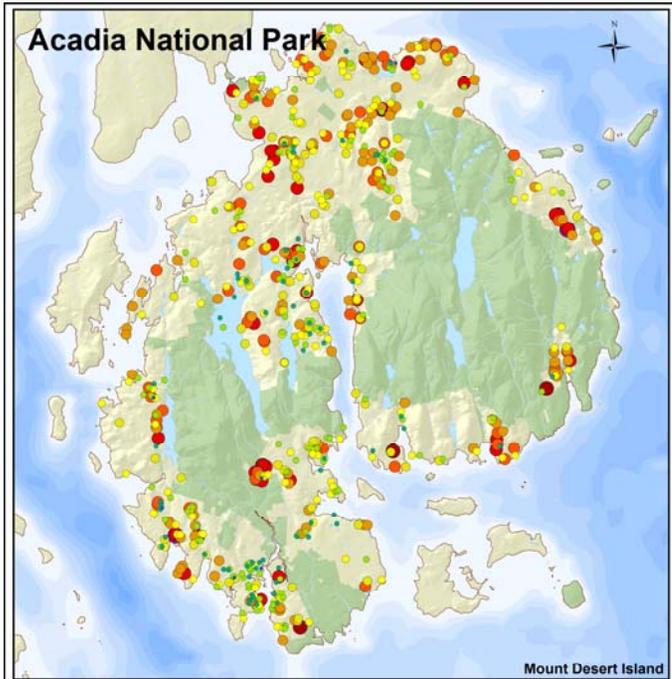
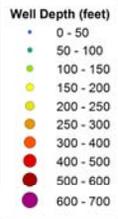


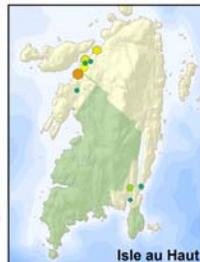
Figure 21. Relationship between number of aquatic macrophyte species (per lake) and (A) lake area, (B) alkalinity in ACAD and other Maine lakes. ACAD lakes are shown in as yellow diamonds. (From Vaux 2005)



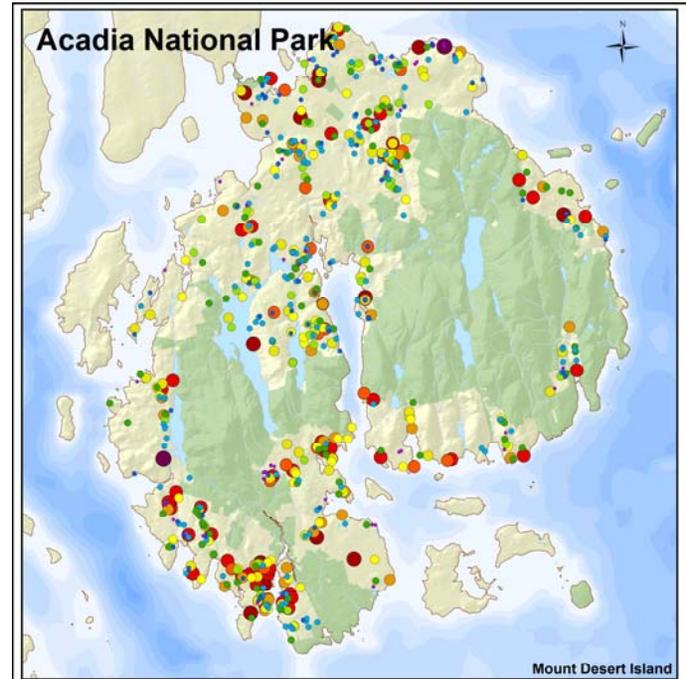
### Bedrock well depth



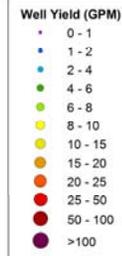
Data courtesy of Maine Geological Survey, 2007



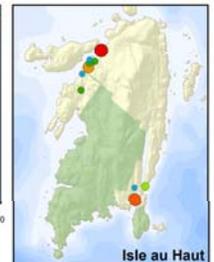
Produced by Environmental Data Center and University of Maine



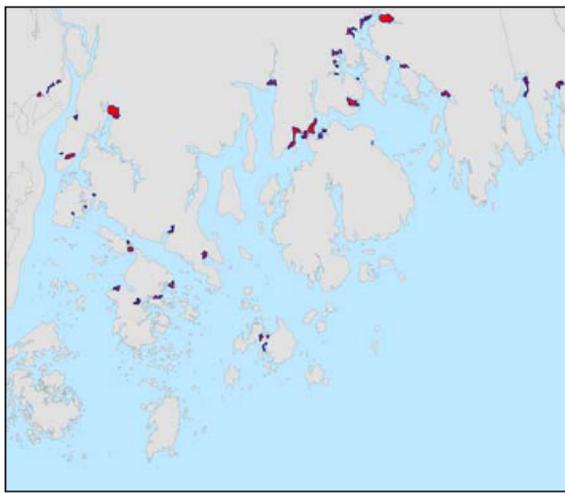
### Bedrock well yield



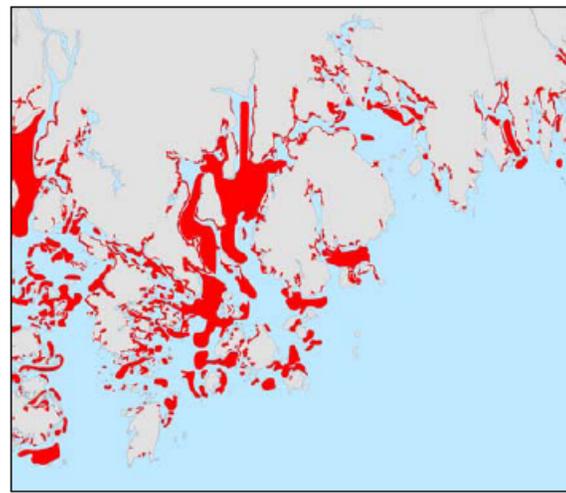
Data courtesy of Maine Geological Survey, 2007



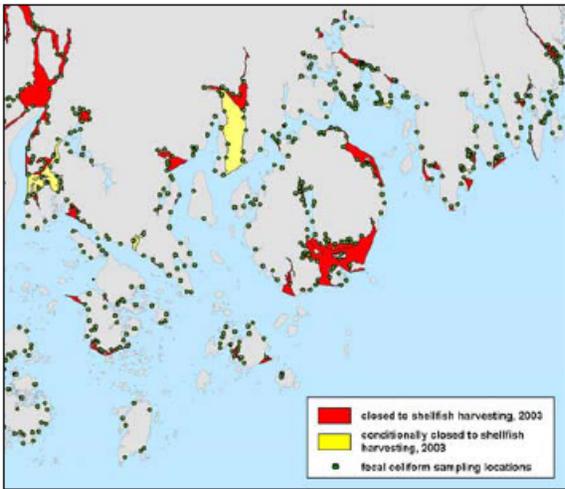
Produced by Environmental Data Center and University of Maine



(A)



(B)



(C)

Figure 31. Worm and shellfish habitat and shellfish closures in the ACAD region.

(A) Marine worm and (B) shellfish habitat in the 1970s.

Maps were produced from GIS data from Maine Office of GIS (<http://megisims.state.me.us/metadata/worm.htm>) and are based on original maps in Fefer and Schettig (1980).

(C) Areas closed (red) and conditionally closed (yellow) to shellfish harvesting as of July 2003.



Table 18. Compilation of visitor use statistics.

<b>A. Visitors to ACAD (see Figure xx)</b>		
<b>B. Visitors, Cadillac summit <sup>(1)</sup></b>		
# persons (2001)	5969	
# persons (2002)	4930	
# cars (2001)	1971	
# cars (2002)	1802	
<b>C. Average # hikers / hour on summits: 1999-2001 (# observation days) <sup>(2)</sup></b>		
Beehive	59 (3)	
Penobscot	47 (1)	
Champlain	43 (4)	
Gorham	34 (20)	
Beech	30 (12)	
Acadia	27 (10)	
Pemetic	19 (7)	
Dorr	15 (8)	
Sargent	10 (3)	
Bernard	2 (1)	
<b>D. # Hikers entering trails on: <sup>(3)</sup> (See also Figure xx)</b>		
	<b>Eastern MDI</b>	<b>Western MDI</b>
1999	2759 (42)	2090 (16)
2000	3370 (48)	1726 (20)
2001	3513 (48)	2896 (21)
2002	5219 (50)	2717 (21)
2003	3586 (43)	1904 (18)
<b>E. IAH trail use: average # visitors / trail / day <sup>(4)</sup>:</b>		
0.6 (low-use trails - 10.4 (high-use trails)		
<b>F. Estimated daily carriage road use (<math>\pm</math> 80% confidence interval) for: <sup>(5)</sup></b>		
	<b>July</b>	<b>August</b>
1997	1663 (208)	1984 (216)
1998	1431 (208)	1796 (211)
1999	1567 (207)	1851 (212)
2000	1379 (208)	1755 (210)
2001	1362 (208)	1552 (207)
2002	1632 (257)	1867 (258)
<b>G. Places visited by visitors (N = 1062 visitor groups) <sup>(6)</sup></b>		
Cadillac summit – 76%	Eagle Lake parking area – 32%	Schoodic Peninsula – 11%
Sand Beach/Thunder Hole – 75%	Sieur de Monts area – 32%	Baker Island – 5%
Jordan Pond House - 61%	Acadia Mt. parking area – 28%	Isle au Haut – 2%
Visitor Center – 59%	Pretty Marsh picnic area – 16%	Other park islands – 7%
Seawall area – 55%		
<b>H. Visitor use at Anenome Cave <sup>(7)</sup></b>		
Average # persons entering case per 3-hour period around low tide, May-August, 1998-99 = 47 ( $\pm$ 9)		

Data sources: (1) Jacobi 2001a, 2003a. (2) Jacobi 2001b, 2003c. (3) Jacobi 2003d. (4) Marion 2006. (5) Jacobi 2003b. (6) Littlejohn 1999. (7) Jacobi 2000.





## Threats

- UV-B, Ozone, Deposition (N, S, H<sup>+</sup> *et al.*)
  - Hg
  - Nutrient enrichment
- Microbial & other contaminants
  - Fire
  - Altered hydrology
  - Habitat loss / impairment
- Visitor use & habitat disturbance
  - Harvest / hunting / take
    - Exotic species
    - Pests & pathogens
    - Climate change
    - Multiple stressors



# Threats analysis

-- incorporates condition-related data

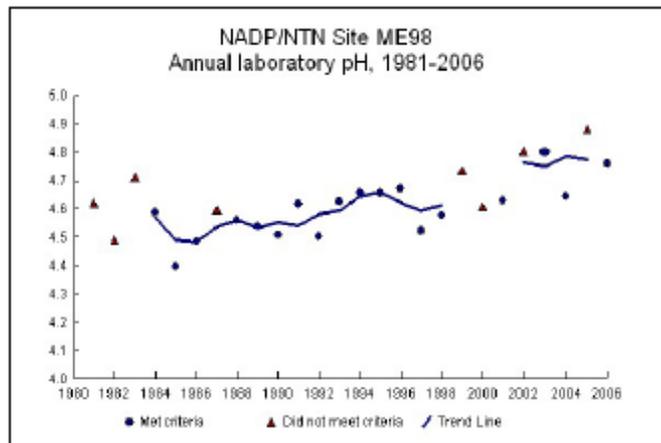
- Synthesize information on agents of change – incl. spatial & temporal patterns
  - Review impacts on abiotic & biotic ecosystem components
    - Assess confidence – quantity / quality of information

## Altered Hydrology

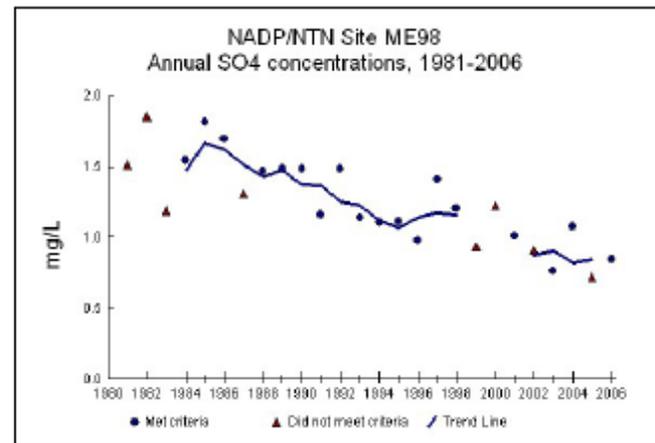
<u>Key Issues</u>	<u>Extent of Problem</u>	<u>Information Base</u>
Lake water level fluctuations	OK	Good
- impacts on biota	UNK	Poor
Stream discharge	OK	Poor
Groundwater levels	PP	Fair

## Mercury

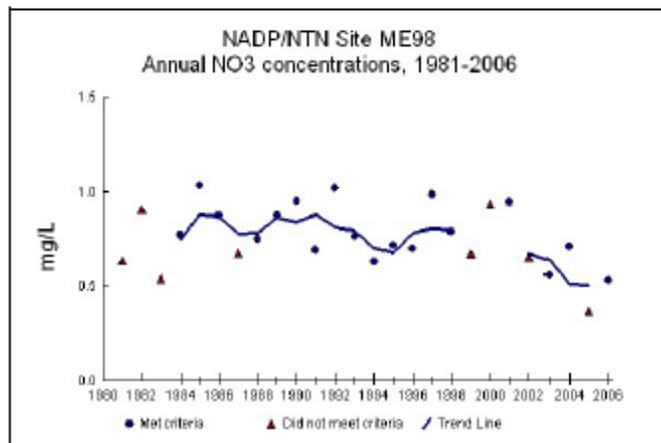
<u>Key Issues</u>	<u>Extent of Problem</u>	<u>Information Base</u>
Atmospheric sources	EP	Good
Hg in terrestrial systems	EP	Good
Hg in freshwater – abiotic components	EP	Good
Hg in biota	EP	Fair
Hg in coastal sediments	OK ?	Good



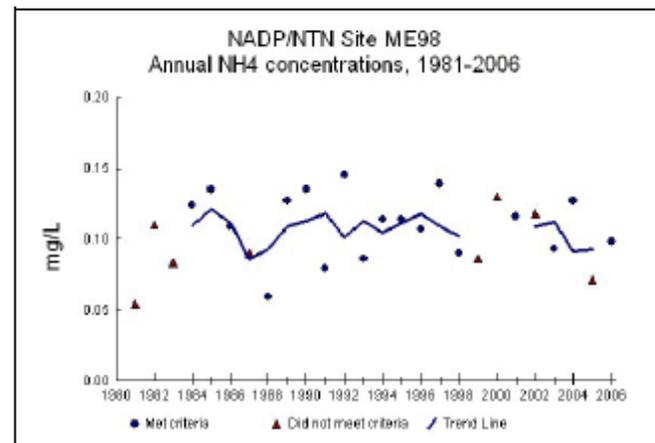
(A)



(B)



(C)

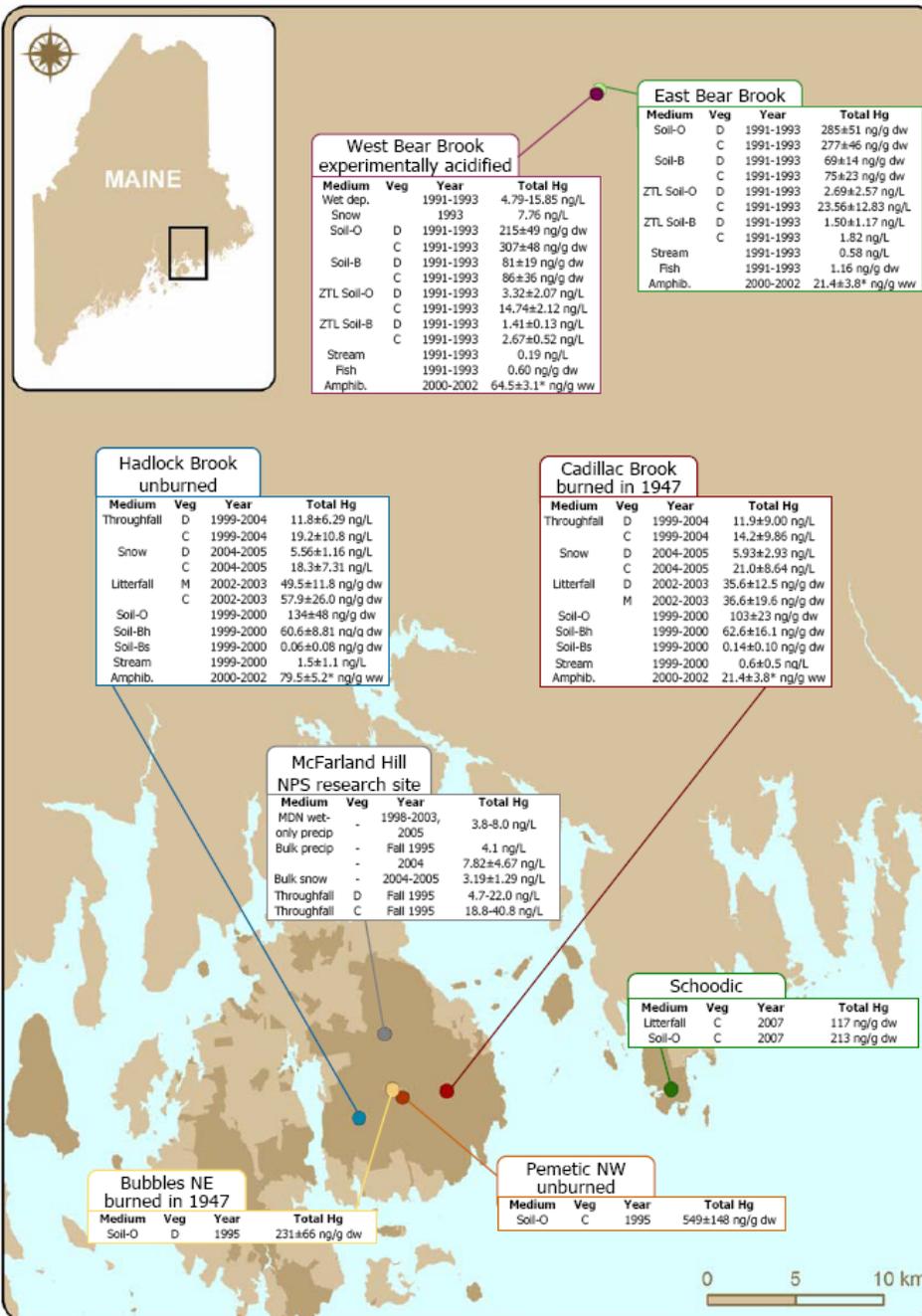


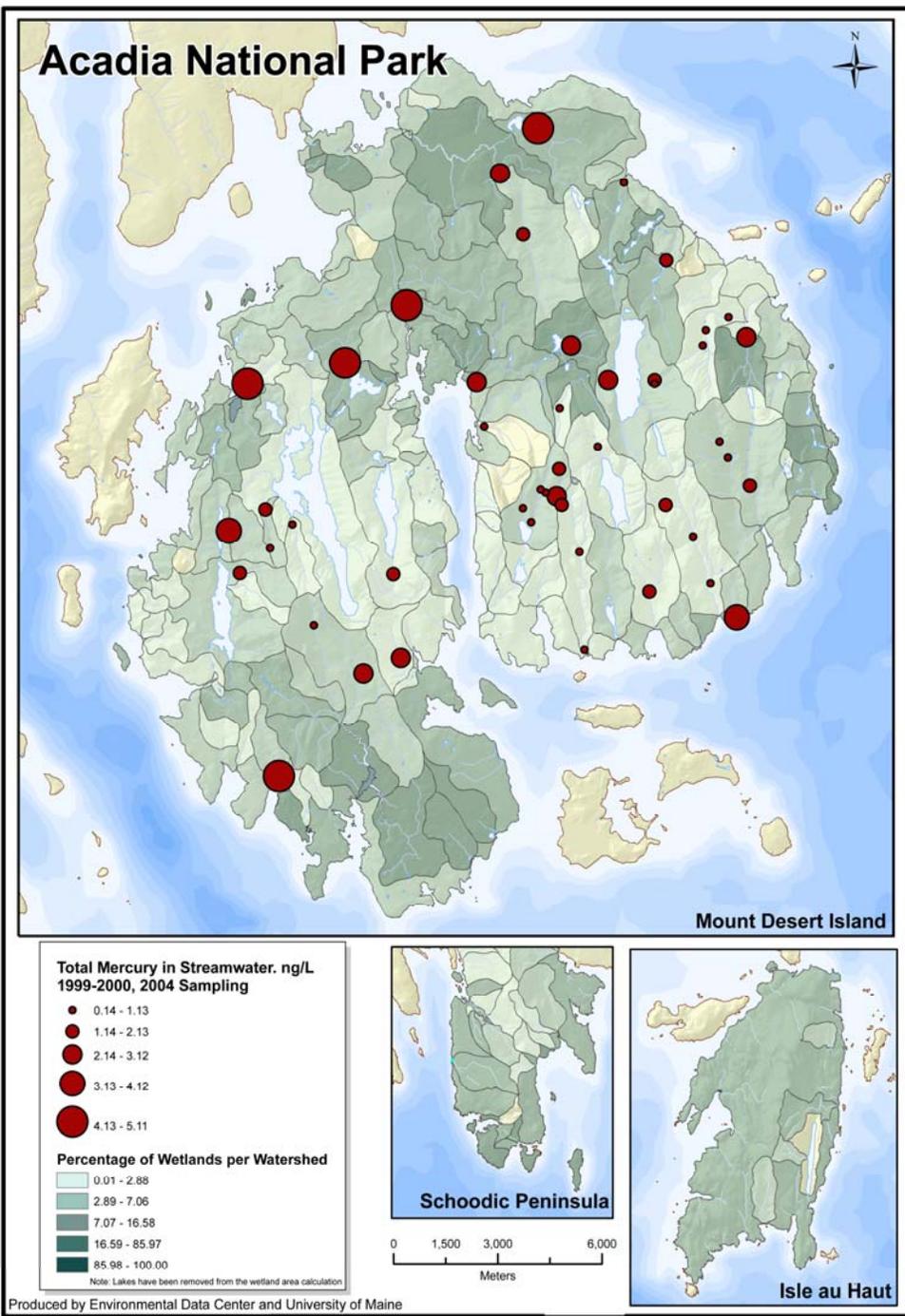
(D)

Figure 36. Precipitation chemistry at the McFarland Hill NADP site, 1981-2006.

(A) pH, (B) sulfate, (C) nitrate, (D) ammonium.

(from <http://nadp.sws.uiuc.edu/trends/trendRequest.asp?site=ME98>, accessed September 2007)





## Metal: Arsenic

### 2000-2003 Northeast NCA Data

State = ME

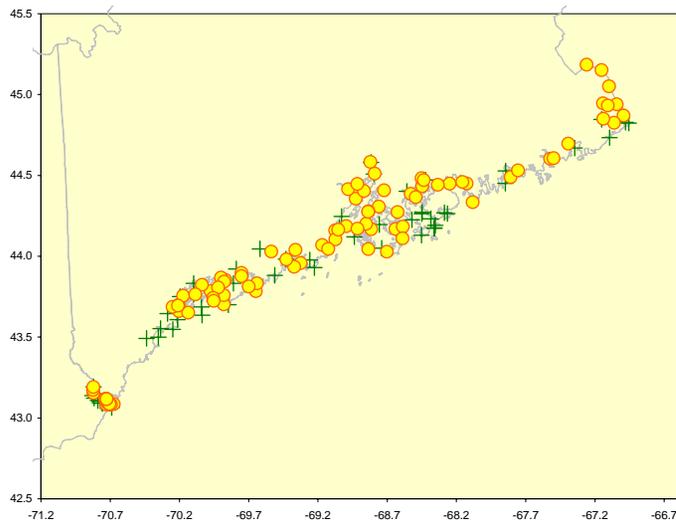
ERL/ERM threshold limits are in effect

ERL = 8.2 ppm

ERM = 70 ppm

**State map** Symbols designate condition as defined in legend below.

Pie diagram & statistics table indicate percentage of estuarine area in state in 4 condition categories



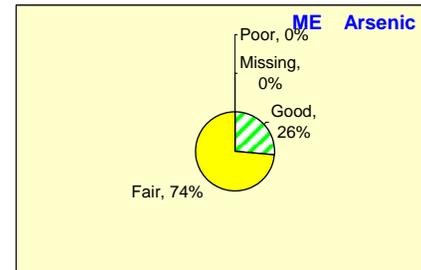
+ Good: <8.2 ppm

● Fair: 8.2 to 70

▲ Poor: >70 ppm

◇ Missing

#### State pie chart:



#### State statistics:

Percentage of Estuarine Area in ME

Good 26.4%

Fair 73.6%

Poor 0.0%

Missing 0.0%

Table 24. Resource stressor matrix showing extent of problem and knowledge base.

THREAT / STRESSOR	RESOURCE – COMPONENT								
	Terrestrial		Lakes & Streams		Wetlands & Estuaries		Grnd water	Marine	
	<i>Abiotic</i>	<i>Biotic</i>	<i>Abiotic</i>	<i>Biotic</i>	<i>Abiotic</i>	<i>Biotic</i>	<i>Abiotic</i>	<i>Abiotic</i>	<i>Biotic</i>
UV radiation	--	Unk	--	PP	--	PP	--	--	Unk
Visibility	EP	--	--	--	--	--	--	--	--
Ozone	EP	EP	--	--	--	--	--	--	--
Atm. deposition: acidity etc.	EP	EP	EP	PP	Unk	PP	--	Unk	Unk
Nutrient enrichment	EP	PP	EP	Unk	PP	PP	PP	PP	PP
Mercury	EP	EP	EP	EP	EP	EP	Unk	OK?	Unk
Other contaminants	OK	PP	EP/PP	Unk	PP	Unk	EP	PP	PP
Microbial contam.	--	--	PP	OK	Unk	Unk	Unk	PP	EP
Fire	EP/PP	EP/PP	--	--	--	--	--	--	--
Altered hydrology	--	--	OK	Unk	PP	PP	PP	--	--
Habitat loss/impairment	--	PP	--	EP	--	OK	--	--	PP
Visitor use	EP	EP	Unk	PP	Unk	Unk	--	OK	EP
Herbivory & predation	--	OK/PP	--	Unk	--	Unk	--	--	PP
Exotic species	--	EP	--	EP/PP	--	PP	--	--	PP
Harvest / hunt / take	--	PP	--	PP	--	Unk	--	--	PP
Pests & pathogens	--	PP	--	Unk	--	EP	--	--	Unk
Climate change	PP	PP	PP	PP	PP	PP	PP	PP	PP
Synergistic impacts from multiple stressors	--	PP	--	PP	--	PP	--	--	PP

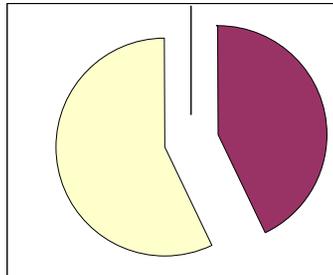
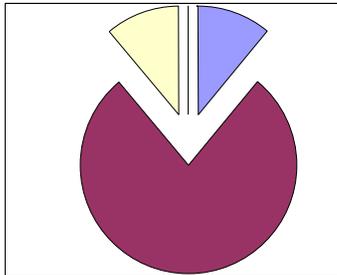
**KEY**

Extent of problem	OK	EP: Existing problem	PP: Potential problem	Unk: Unknown
Knowledge base	Good	Fair	Poor	Inferential

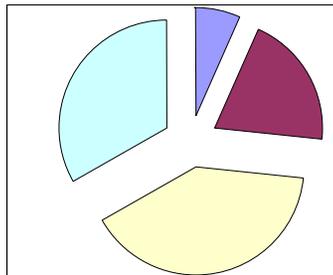
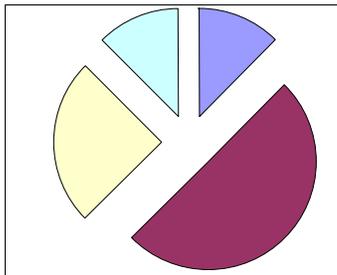


**Threat  
Levels**

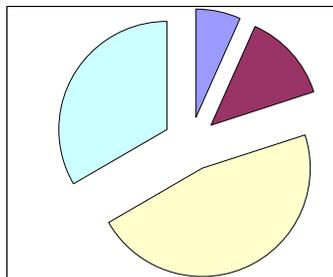
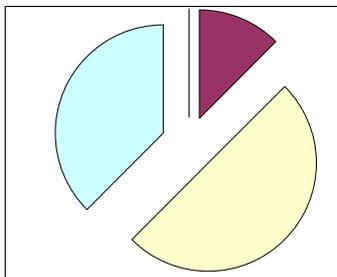
TERR



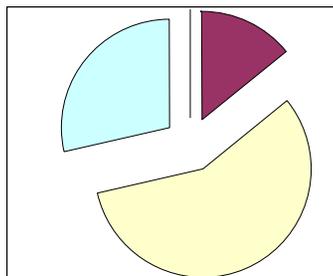
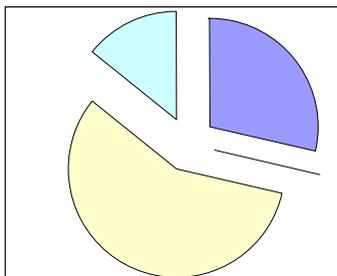
L&S



WET/EST



MAR



Abiotic

Biotic



OK



Existing problem



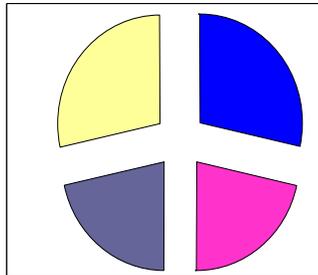
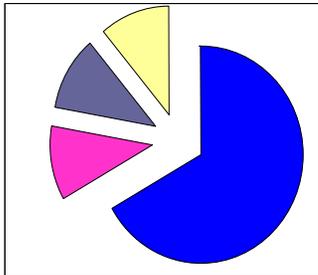
Potential problem



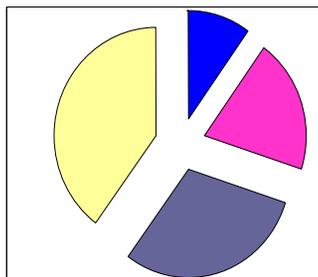
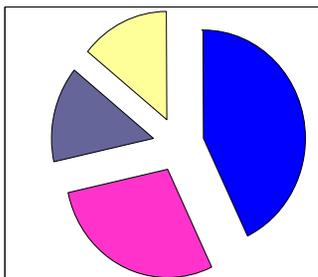
UNK



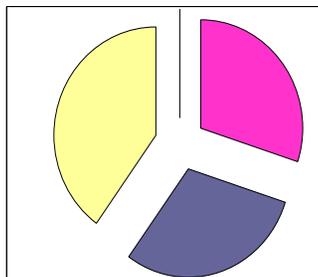
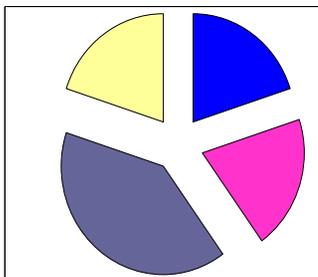
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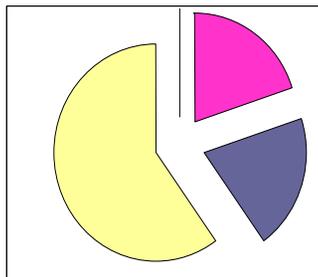
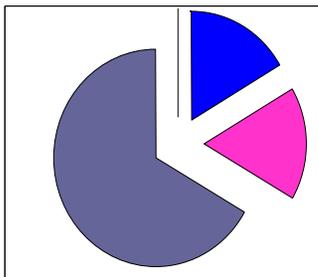
L&S



WET/EST



MAR



Abiotic

Biotic

Good

Fair

Poor

Inferential only

**Information  
Quantity  
(Confidence)**



# Condition Assessments

Metrics & information  
availability ....

Resource / Metrics	Existing data used for condition assessment	
	Time series	Status only
<b>Air Quality</b>		
Ozone	Multiple years and sites	
Visibility	Multiple years and sites	
N, S, H <sup>+</sup>	Multiple years and sites	
Hg	Multiple years and sites	
Other contaminants	Multiple years and sites	
<b>Lakes</b>		
Stage height	Multiple years and sites	
Temp, pH, Cond.	Multiple years and sites	
D.O.	Multiple years and sites	
ANC	Few years and/or sites	
Nutrients	Multiple years and sites	
SO4	Few years and/or sites	
Hg, other contaminants	Few years and/or sites	
Invasive plants		Many sites
Fish	Multiple years and sites	
Loons	Multiple years and sites	
<b>Streams</b>		
Hydrology	Few years and/or sites	
Temp, pH, Cond., ANC	Few years and/or sites	
Nutrients	Few years and/or sites	
SO4, Cl	Few years and/or sites	
Hg, other contaminants	Few years and/or sites	
Barriers		Many sites
Other geomorphology		
Fish		Many sites
Amphibians	Few years and/or sites	
Macro-invertebrates	Few years and/or sites	
<b>FW Wetlands</b>		
Hydrology		
pH, Cond.,		Few sites
Nutrients		Few sites
Landscape context		Few sites
Plant assemblages		Few sites
Invasive species		Few sites
<b>Estuaries</b>		
Nutrients		Many sites
Plants		Many sites
Fish		Many sites

<b>Marine - intertidal</b>		
Algal assemblages	Few years and/or sites	
Invertebrate assemblages		Few sites
Trampling		Few sites
Exotic species		Few sites
<b>Terrestrial</b>		
Bird assemblages (not at plot level)		Many sites
Bird abundance (not at plot level)	Few years and/or sites	
Birds – at plot level		
Invasive plant species		Many sites
Tree condition (few metrics)		Few sites
Tree mortality, growth, regeneration		Few sites
Forest patch size, stand structure		
Deer browse	Few years and/or sites	
Mammals – population size, mortality		Few sites
Landscape context		
Snags, CWD		
Trampling		Few sites
Soil chemistry		Few sites

**Condition metrics:  
information availability**

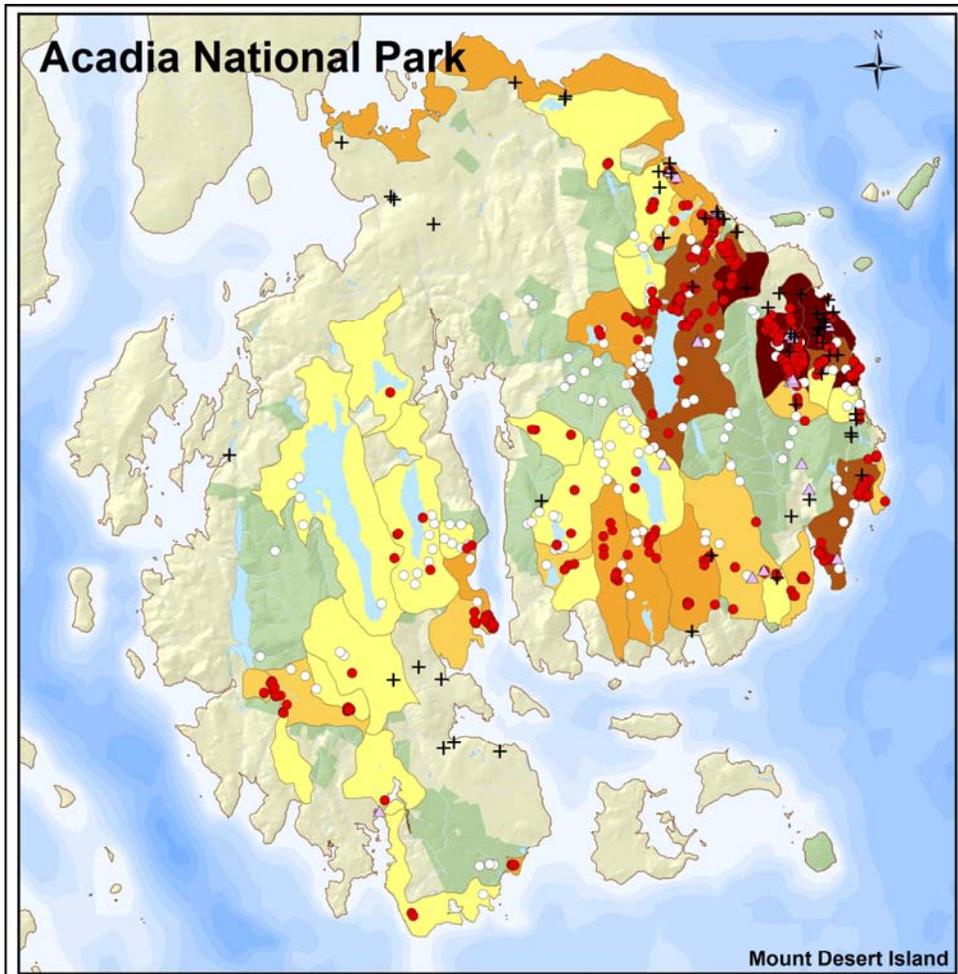
Multiple years and sites
  Few years and/or sites
  Many sites
  Few sites



# Condition Assessments

## Benchmarks

- Park goals *e.g. no exotics*
- External criteria  
*e.g. stream macroinvertebrates, Hg burdens, trophic state*
- Historical (i.e. trends)  
*e.g. lake transparency, dissolved oxygen*
- Spatial frameworks:
  - state
  - ecoregion / biophysical region
  - broader region / national*e.g. lake transparency, water chemistry, Hg in biota, atmospheric deposition*



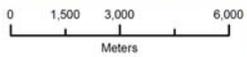
Mount Desert Island

## Invasives: Flora

- Sites Sampled
- Invasives Found
- ▲ Lupine (2005)
- + Purple Loosestrife (2004)

**Species Richness**

- 1 - 2
- 3 - 4
- 5 - 6
- 7 - 10
- 11 - 15



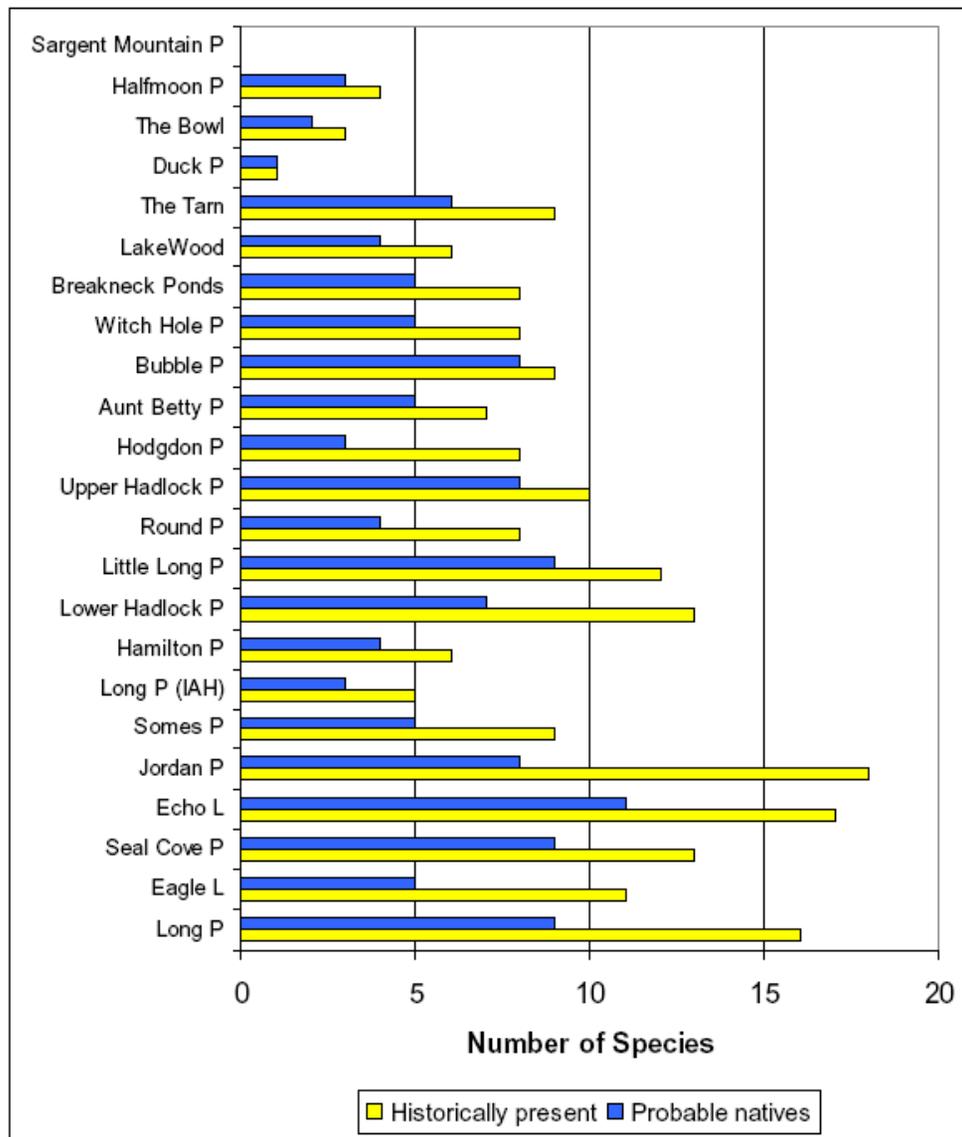
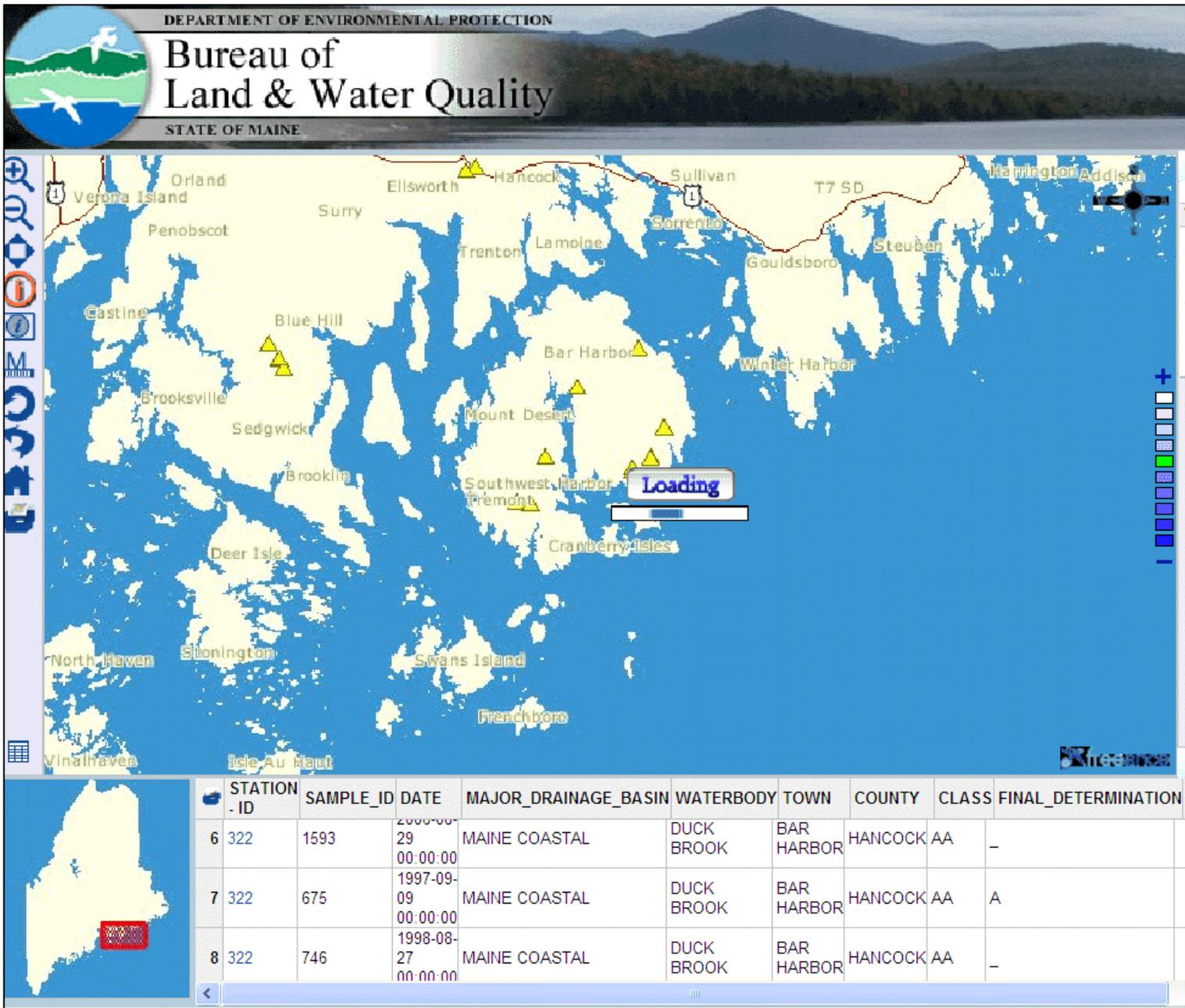
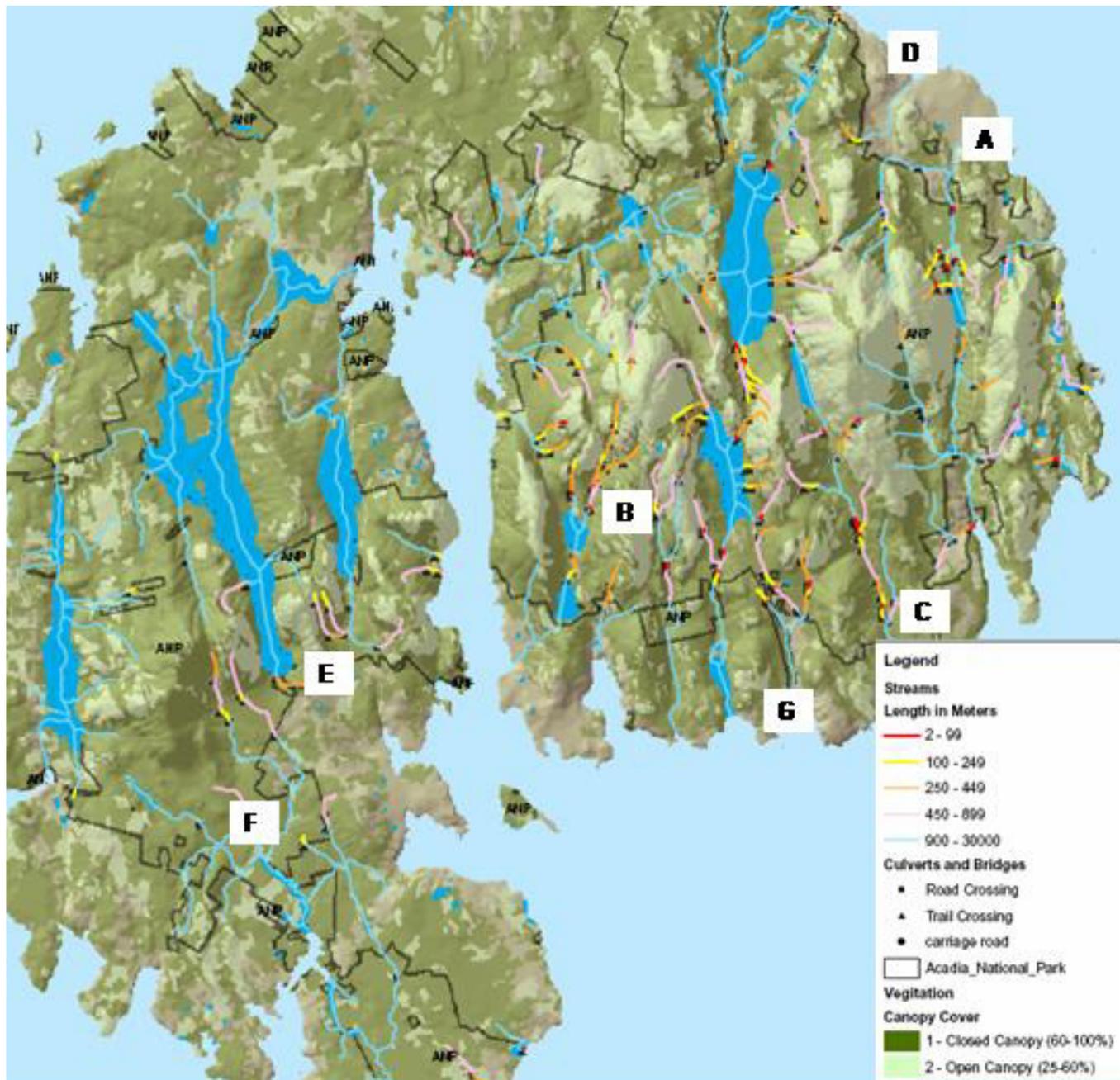


Figure 24. Fish species richness of ACAD area lakes and ponds. “Historically present” indicates all species known to have been present. “Probable natives” are species thought to be natives to the specific waterbody. Data from Bowes *et al* 1999.



*Stream macroinvertebrate assemblage metrics – statewide assessment system.*



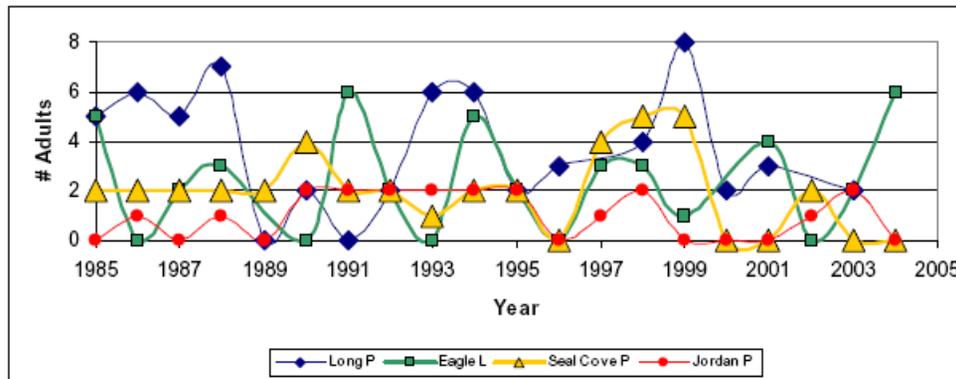
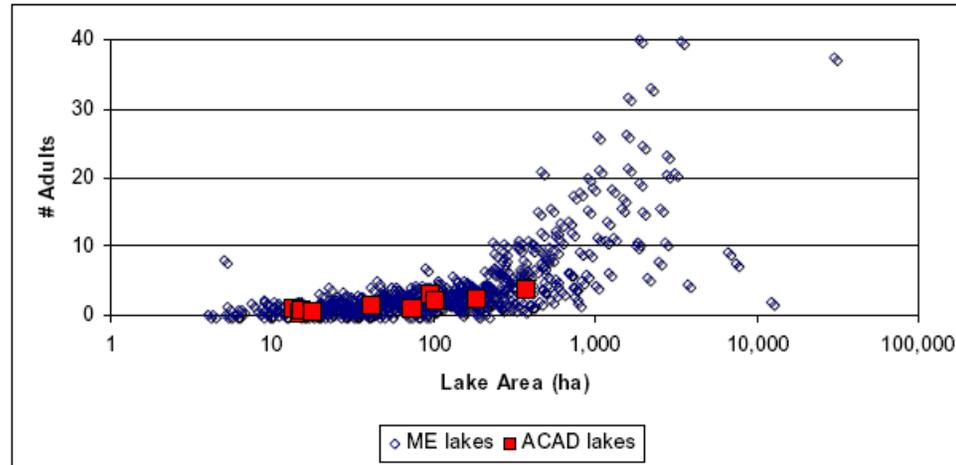
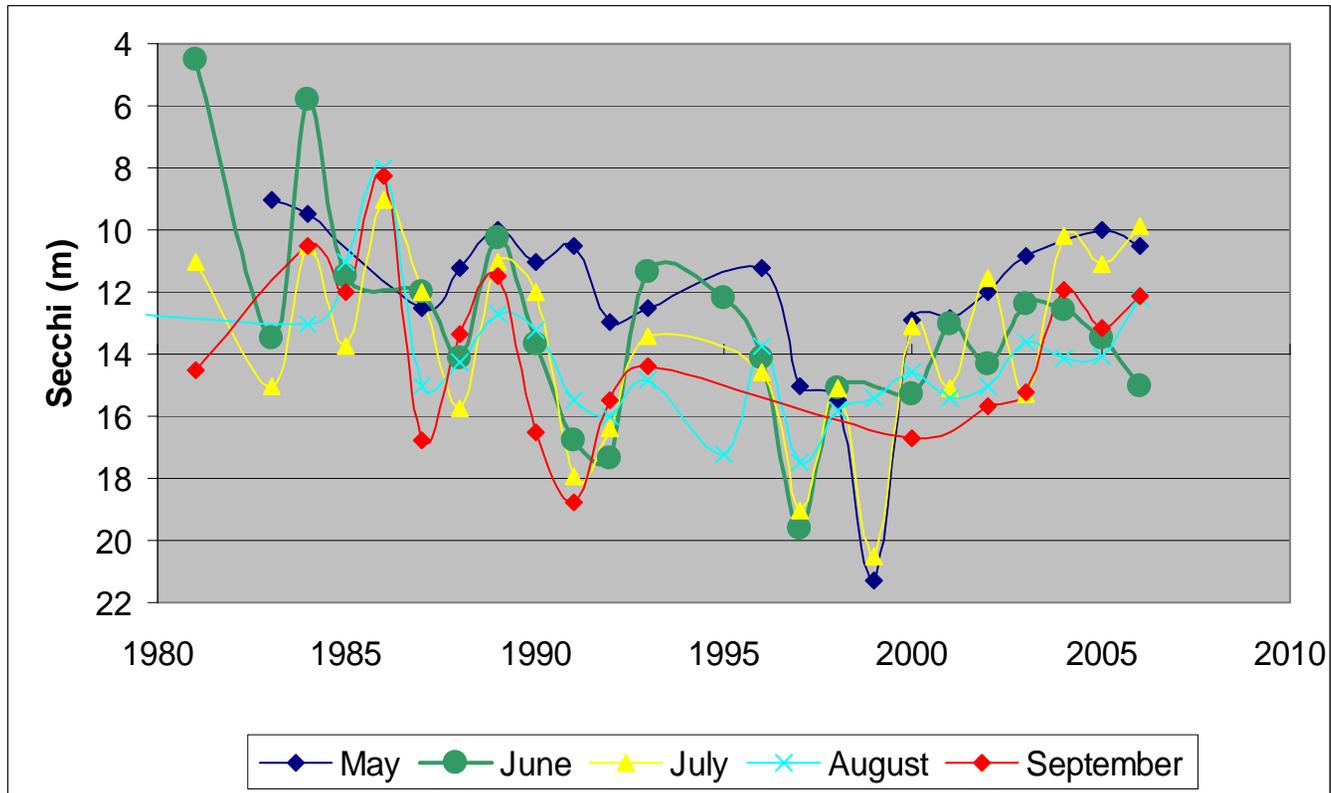


Figure 22. Loon populations on Maine and ACAD lakes. Upper panel shows average number of adults counted during July loon census as a function of lake area (data are for the period 1983-2004; the number of years with data varies among lakes). Lower panel shows temporal patterns in adult numbers on four ACAD lakes. Data source: Maine Audubon data accessed at [www.pearl.maine.edu](http://www.pearl.maine.edu).

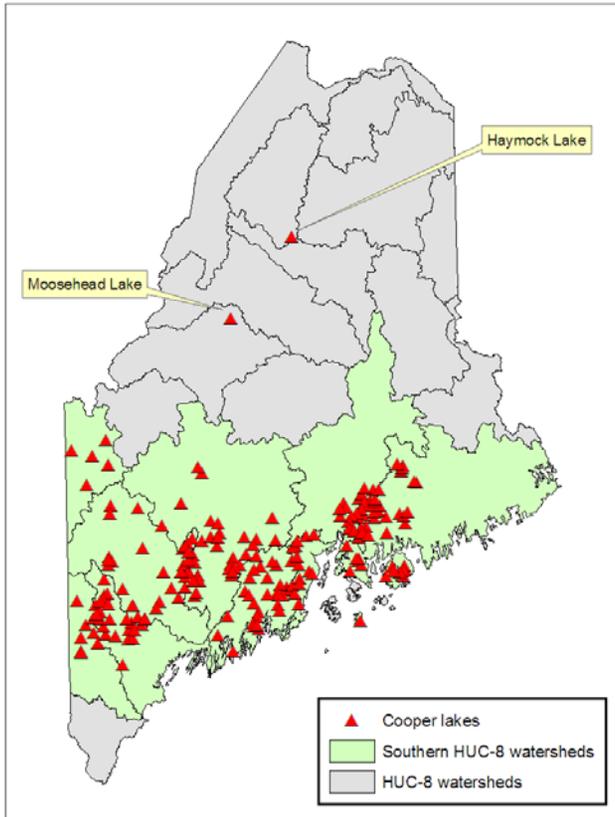
*Historical data: Loons*



Water transparency (Secchi depth) by month and year in Jordan Pond.

*Historical data: Lake transparency*

# Hypolimnetic Dissolved Oxygen Depletion – 60-year comparison: 1942, 1980s-2006

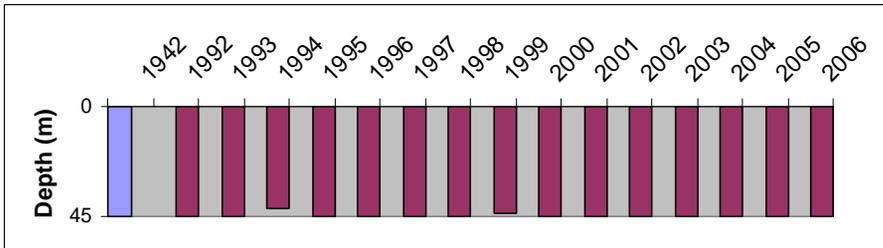


1942 lake  
surveys

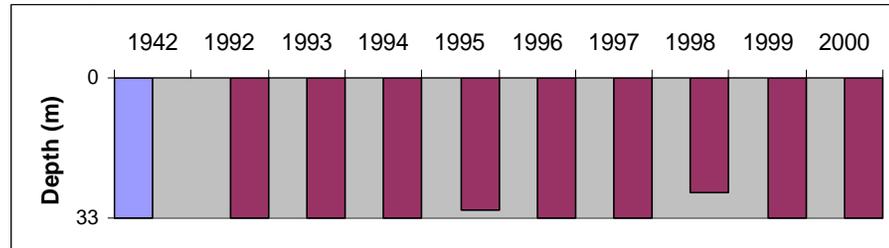




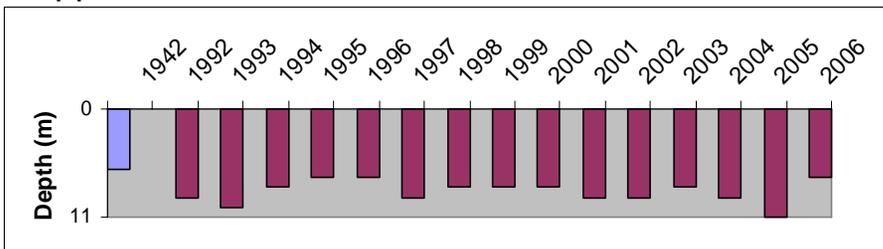
### Jordan Pond



### Eagle Lake

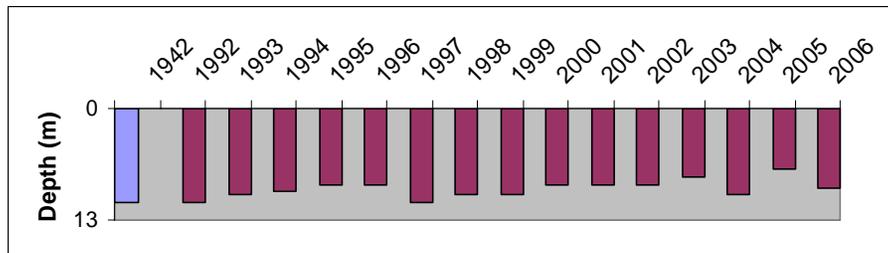


### Upper Hadlock

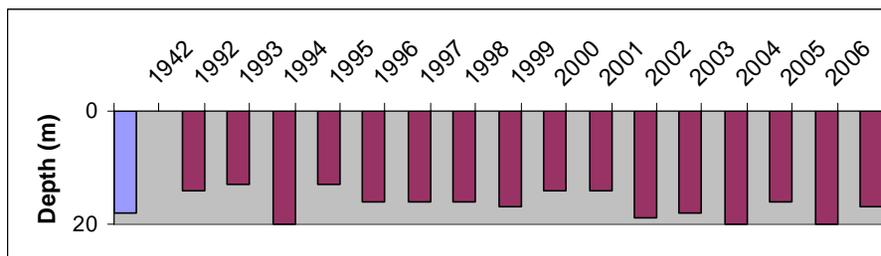


Extent of water with >3.0 mg/L D.O.  
➡ No sig. trends over 60+ years

### Seal Cove Pond



### Echo Lake



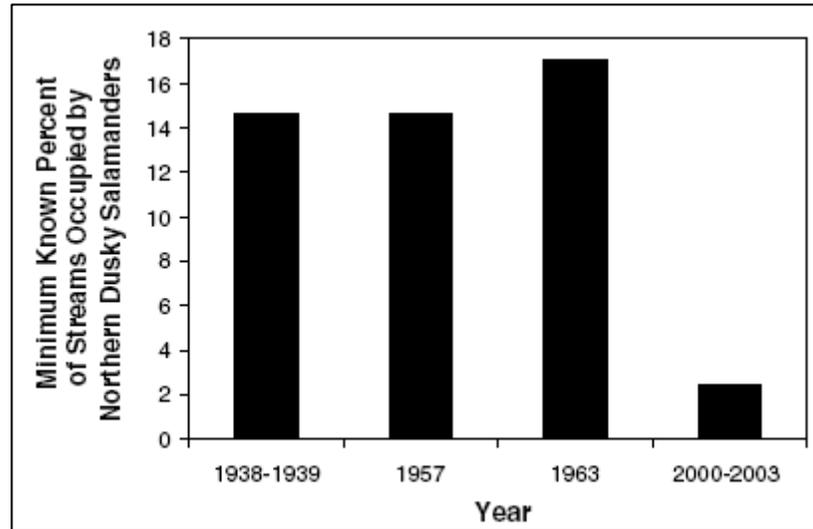
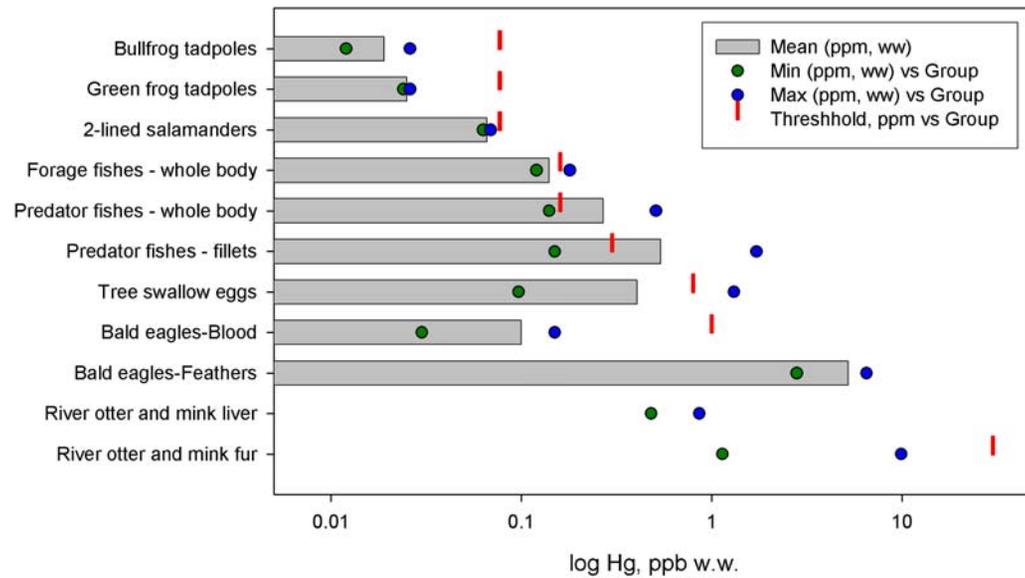
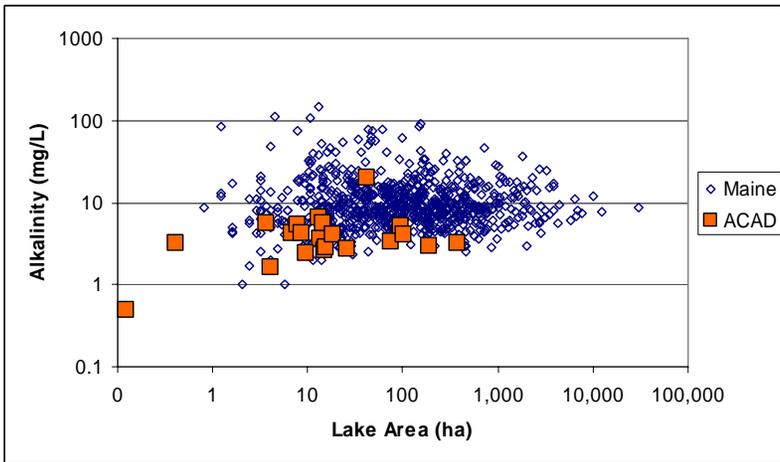


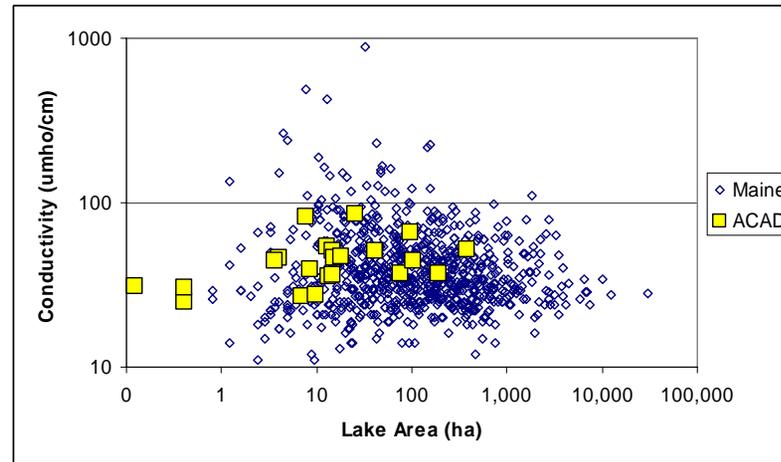
Figure 11. Minimum known percent of streams ( $n = 37$ ) occupied by northern dusky salamanders in ACAD, 1938–2003. (Figure from Bank *et al.* 2006)

*Historical data: Salamanders*

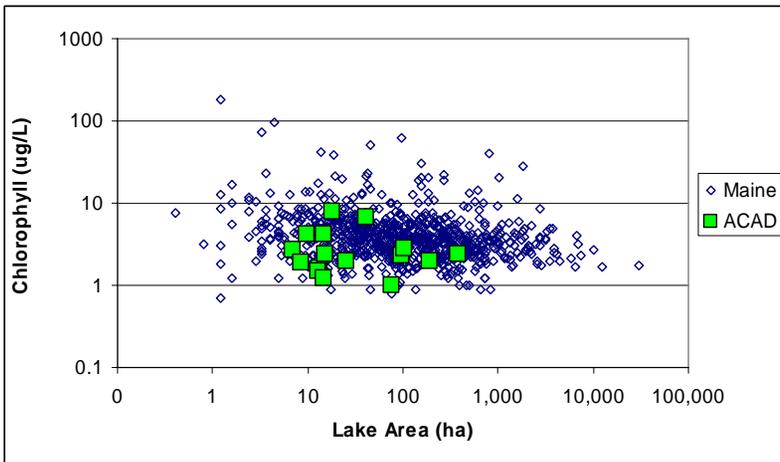




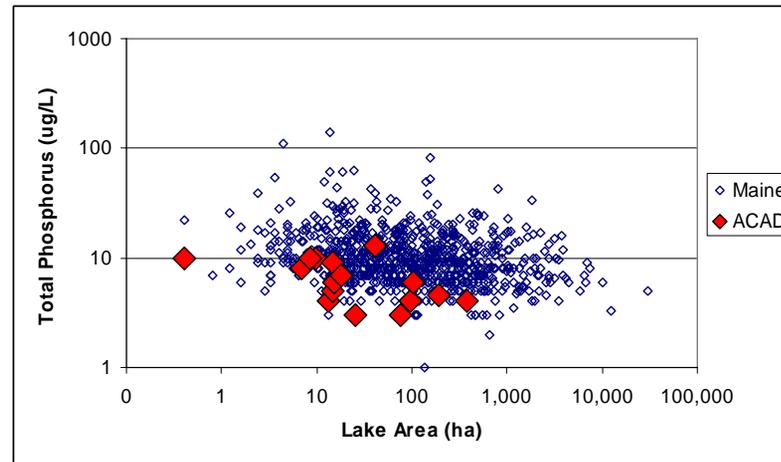
Alkalinity



Conductivity

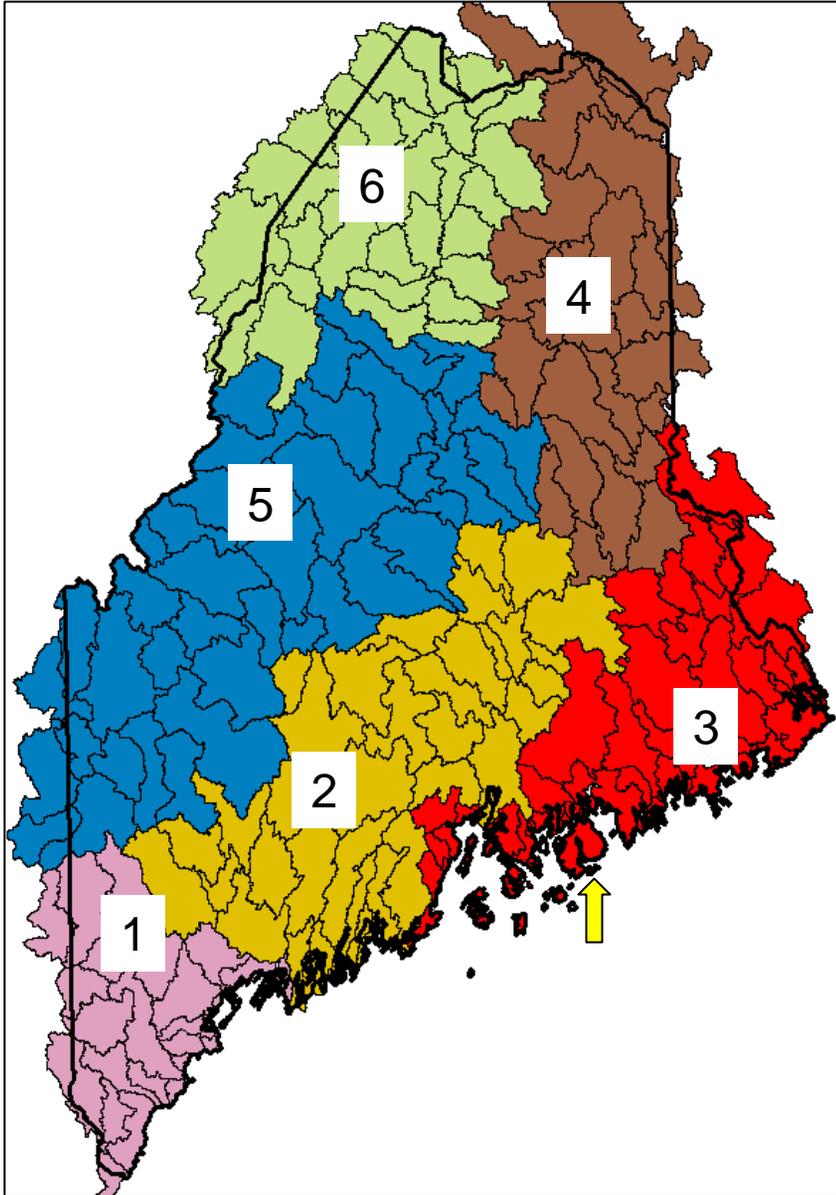


Chlorophyll

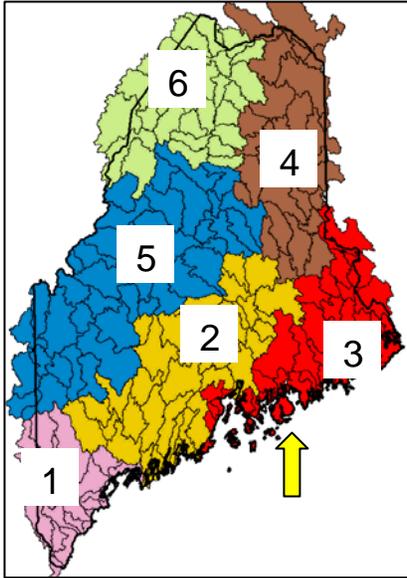


Phosphorus

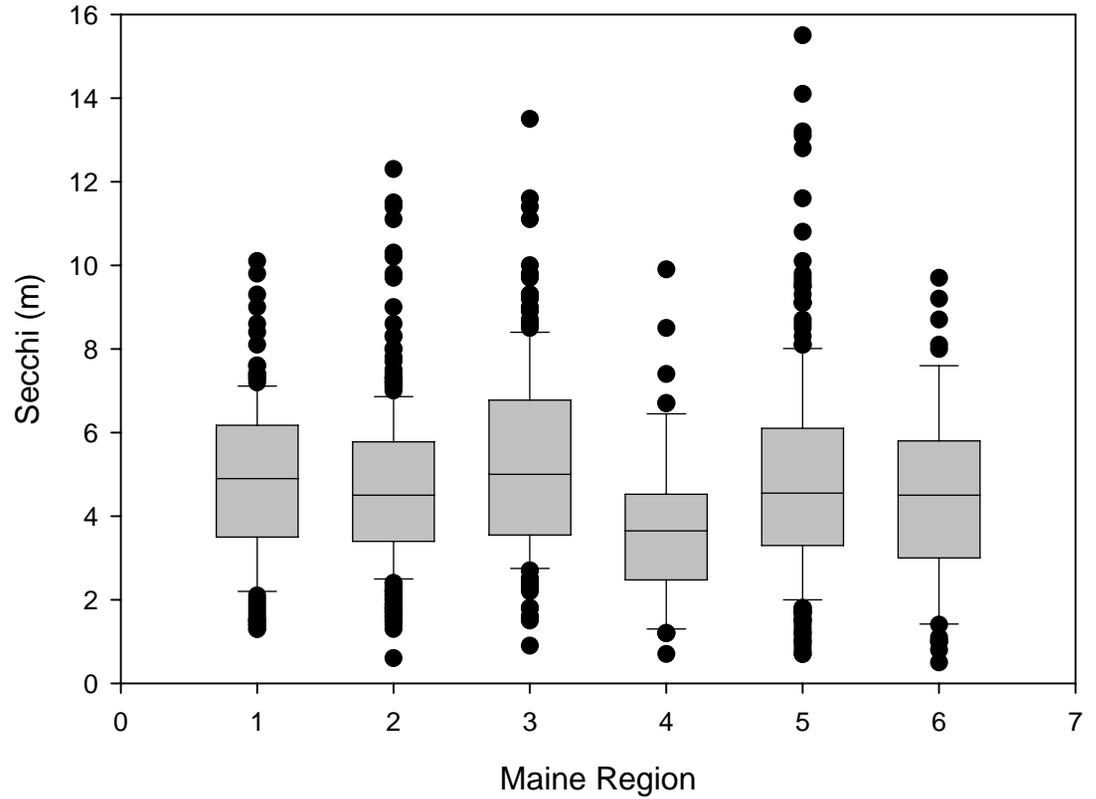
Water quality of ACAD lakes compared to all surveyed ME lakes

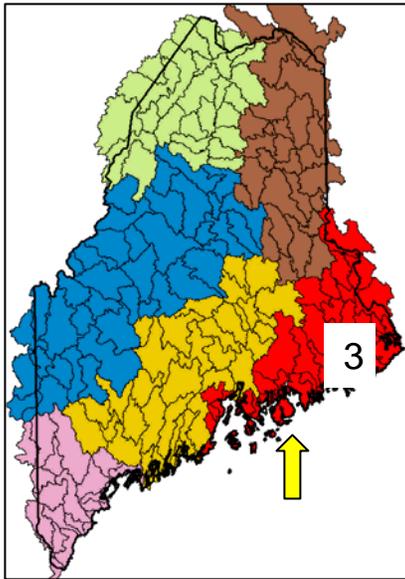


*Group Maine's HUC-10 watersheds into six biophysical regions*

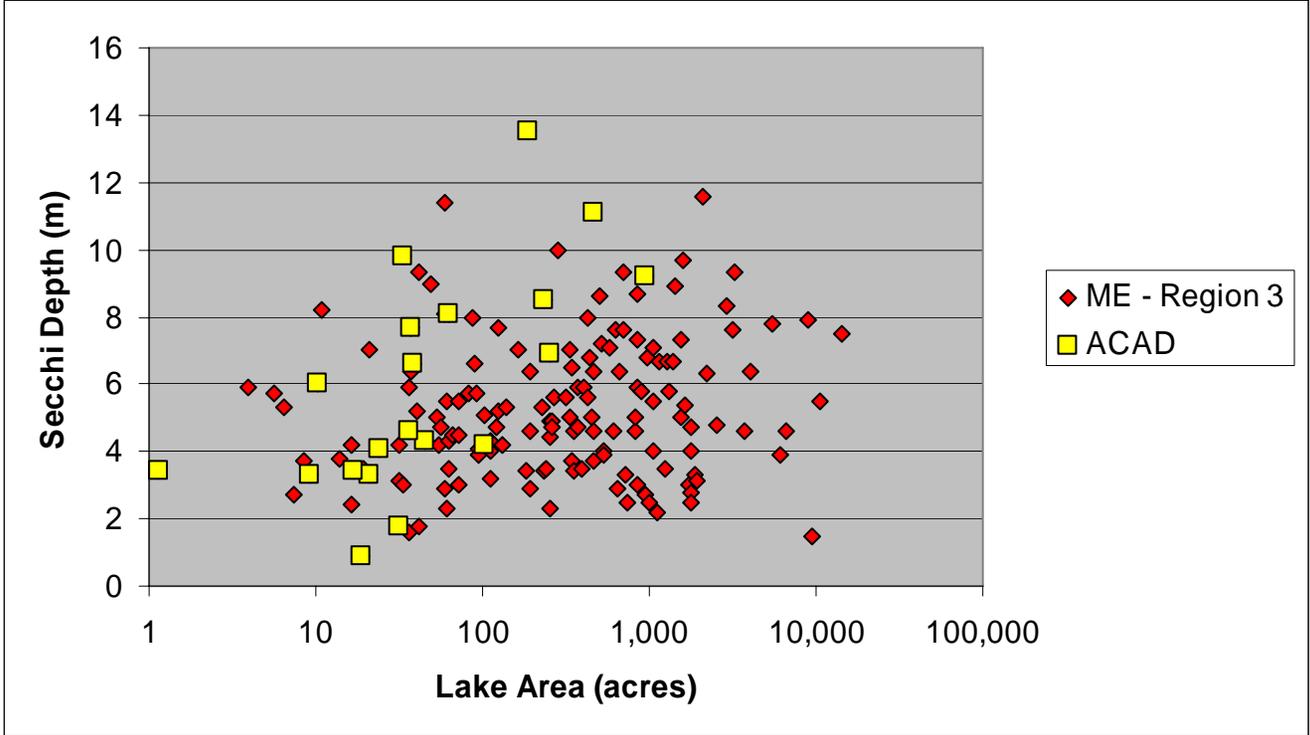


# Mean lake Secchi by region

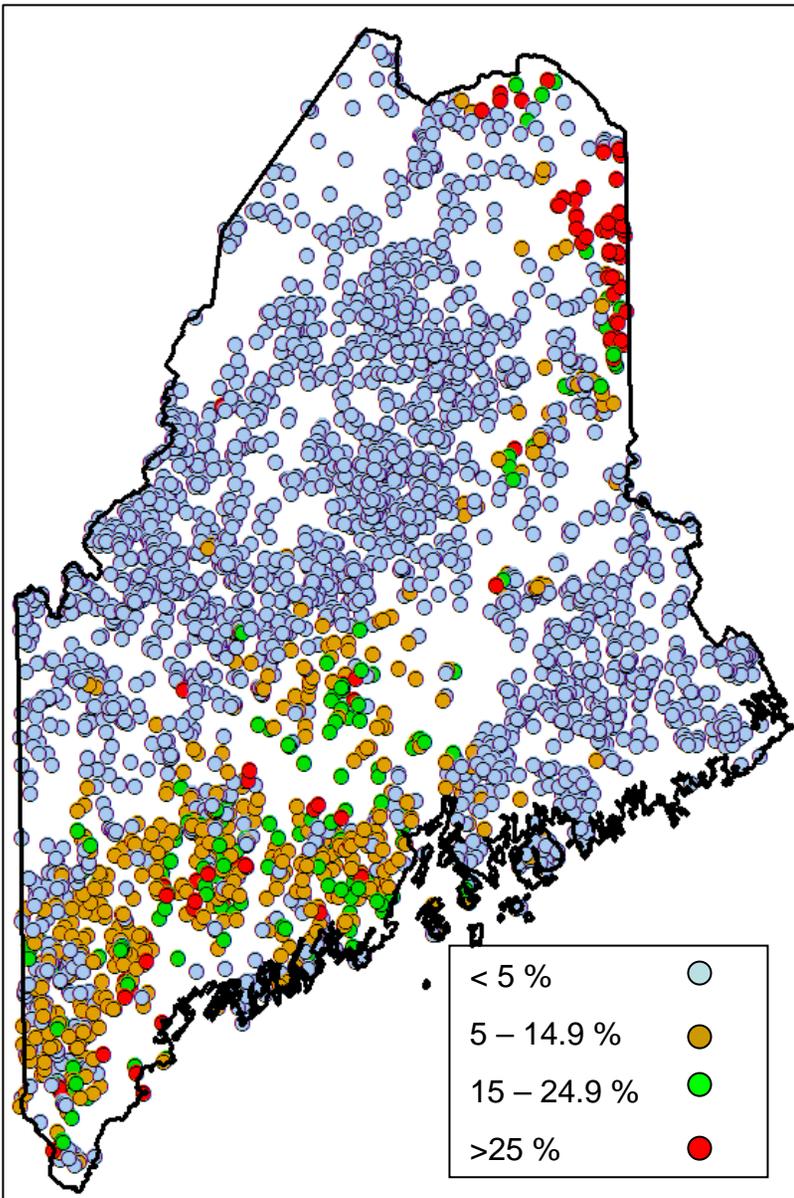


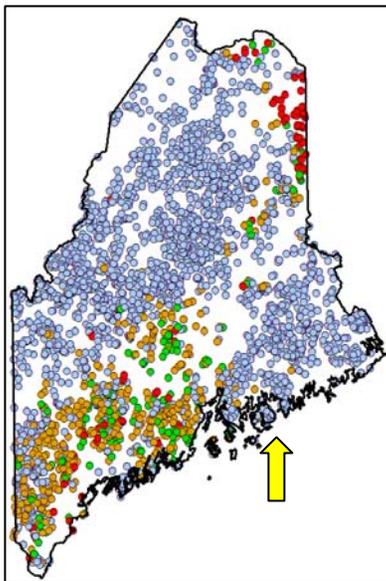


Compare transparency in ACAD lakes with ME lakes in same biophysical region (3)

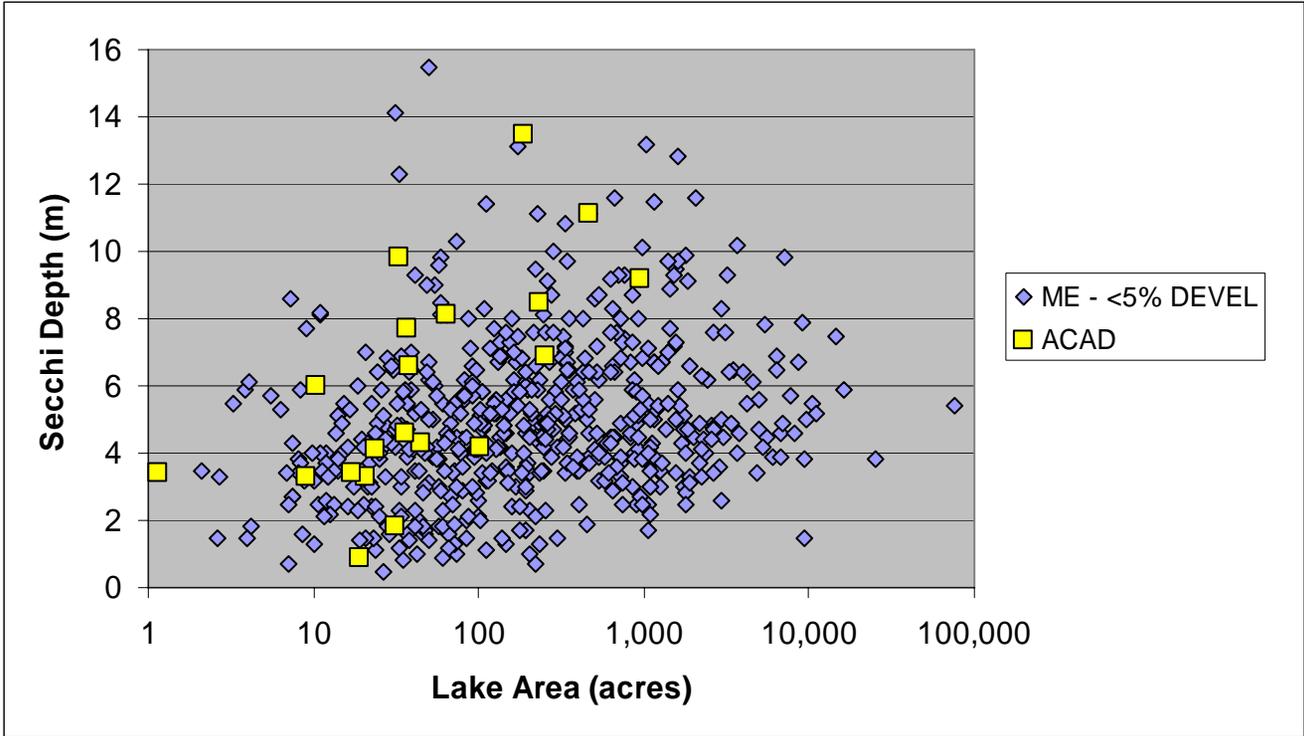


Classify lakes by %  
development + agriculture in  
direct-draining watersheds





Compare transparency in ACAD lakes with ME lakes having least developed watersheds (<5% devel. + agric.)



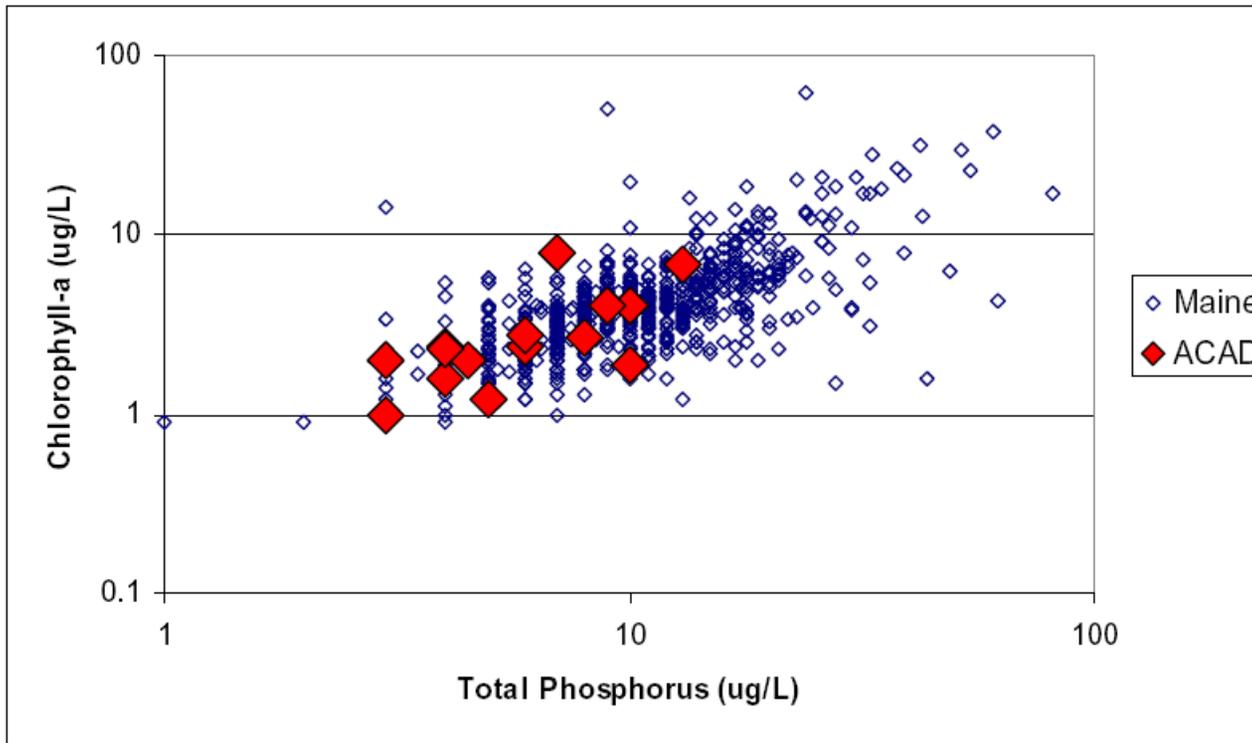
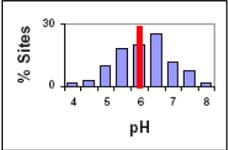
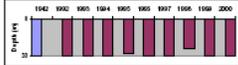
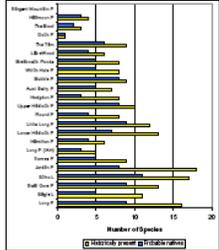
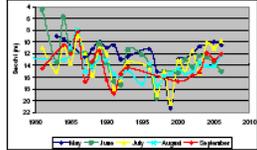


Figure 51. Relationship between total phosphorus and chlorophyll concentrations in Maine and ACAD lakes. Data are overall averages for each lake, calculated by MDEP and accessed at [www.pearl.maine.edu](http://www.pearl.maine.edu). Where data were available for >1 basin / lake, data were averaged across basins. Original lakes water quality data were provided to MDEP by ACAD researchers.

<i>Metric</i>	<i>Status (click on thumbnail to see main graphic)</i>	<i>Comments</i>	<i>Condition Grade</i>
Streams: pH	 <p>Reference <math>\geq</math> 6. 67% sites better than ref</p>	<ul style="list-style-type: none"> <li>• Episodic acidification; some improvement since CAAA</li> </ul>	FAIR
<i>Other stream metrics go here...</i>			
Lakes: pH		<ul style="list-style-type: none"> <li>• 2 lakes are acidic; one of these is naturally acidic.</li> </ul>	GOOD
Lakes: Hypolimnetic dissolved oxygen		<ul style="list-style-type: none"> <li>• ACAD lakes are well oxygenated. No evidence of trends over past 60 years</li> </ul>	GOOD
Lakes: Fish		<ul style="list-style-type: none"> <li>• Average 60% fish species currently present in lakes were there historically.</li> <li>• Two species currently present are non-native to Maine.</li> </ul>	FAIR
Lakes: Transparency		<ul style="list-style-type: none"> <li>• Based on transparency and other criteria, most ACAD lakes are unproductive; a few are moderately productive.</li> <li>• No evidence of long-term trends in water transparency.</li> </ul>	GOOD
Lakes: Invasive plants		<ul style="list-style-type: none"> <li>• No invasive aquatic plants present in ACAD</li> </ul>	GOOD

## Condition summary (in part)